STAYING ALIVE: SUSTAINABILITY IN PHILIPPINE UPLAND MANAGEMENT SYSTEMS

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Abstract

Upland areas are an important but increasingly threatened Philippine ecosystem. Land use intensification, caused mainly by increasing population, has negatively impacted both the local and downstream environments. This study was conducted in three upland communities. Study goals were to describe existing systems, assess system sustainability, identify factors affecting management decision making, develop models of decision making, and identify systems that could serve as models for future development efforts.

The study employed data collected from residents using informal interviews, observations, and a structured questionnaire, as well as information on agronomic, soil and climatic conditions. Three combinations of the agroecosystem analysis properties: productivity, stability, resilience, maintenance, equitability, autonomy, solidarity, diversity and adaptability, were used to assess system sustainability at the household and community levels. A decision tree framework was used to develop household management decision making models.

The sustainability of all three communities was rated low to moderate, and the majority of the twenty example households had moderate sustainability levels. Two households were rated high while three were rated low. Differences in economic and biological productivity and in the magnitude of stress placed on the natural environment were the primary factors that differentiated between the sustainability ratings at both the community and household levels. Both household and community sustainability levels were determined by the dynamic interactions between management activities, soil and rainfall constraints to management activities, and the availability of markets and information.

Decision tree models were developed for agricultural land management decisions in the three communities. The most important influences on decision making appeared to be land availability and type, labor availability, and market opportunities. Seven case studies described household management systems based primarily on perennial species and identified land, labor, markets, and an alternative source of livelihood as the primary contributing factors to the adoption of perennial-based systems.

Study results indicated that the situation in these upland areas was relatively stable. Most management systems were moderately sustainable. Results from the decision making models indicated that the provision of infrastructure, market opportunities, and tenure security were most likely to facilitate adoption of more environmentally sustainable management strategies based on perennial species.

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Chapter 1
Introduction

One consequence of the burgeoning world population and the continued inequitable distribution of land resources in much of the world is that more people are living in tropical upland areas. Upland areas are increasingly being seen as a distinct and potentially important ecosystem and have become the focus of an increasing number of research and development activities. However, these areas continue to be generally neglected by urban-based policy makers. As a consequence, upland residents are generally one of the poorest, most marginal segments of the rural population.

Definition of uplands

One of the first important issues that must be addressed when dealing with the uplands is a definition of what constitutes uplands. For this study, I will use the definition of uplands offered by Garrity (1993, p. 43): "...the undulating and steep lands that range in elevation from near sea level to about 1000m in elevation." Using on this definition, upland areas make up a large percentage of the total land in many countries of the South (from 50% - 90% of the total land area in respective Southeast Asian countries) (Garrity, 1993) and are the home for a significant percentage of their people.

The Philippine uplands

The Philippines provides an example of the areal extent and continuing importance of the upland ecosystem. Unfortunately it also provides vivid examples of many of the negative consequences associated with the misuse of this resource. In this section, I will describe the characteristics of the Philippines uplands, the value of uplands as a resource, problems associated with living in the uplands, outsider perceptions of upland management activities and previous development efforts focused on upland areas.

Areal extent and population

The Philippine uplands occupy at least 55% of the total land surface (Garrity et al., 1993) and are home to an estimated 17.8 million people (nearly 30% of the total). The population of upland areas and of the Philippines as a whole continue to grow at a rapid rate (2.6% per year). Lowland migrants, the bulk of whom (approximately 10 million) have migrated to upland areas since 1948, make up a large and increasing percentage of the upland population (Garrity et al., 1993).

Importance of uplands

Upland areas play several important roles in the Philippines and elsewhere in the humid tropics. First of all, as mentioned earlier, they make up a significant fraction of the total available land. As such, they are an area that deserves further investigation. In addition, upland areas provide livelihoods, although in most cases marginal livelihoods, to a significant percentage of the population. However, uplands have importance beyond areal extent and demographics. Upland areas in the Philippines are an important source of a number of valuable products including much of the country's production of maize, cassava and various fruits and vegetables. Other valuable upland products include grasses, bamboos and timber for building material and wood and charcoal for cooking fuel.

Another important role played by upland areas is for watershed protection. Upland catchment areas serve as valuable sources of drinking and irrigation water for most major Philippine cities and agricultural areas as well as for water used for generating electricity. In addition, proper upland management can mitigate the downstream effects of seasonal flooding and can reduce the damage to reservoirs and near shore fisheries resources caused by sedimentation. A further important use of upland areas is as natural reserves. Upland areas are the habitat of a large number of endangered animal and bird species including the Philippine tamaraw and the Philippine eagle.

Conditions in upland areas

Even though upland areas provide a number of important products, upland residents are among the poorest groups of rural Filipinos. Most upland residents rely on agriculture for a significant portion of their livelihood. However, agriculture in upland areas is often difficult. Although some areas (such as parts of Cavite province and areas of Mindanao) are characterized by young volcanic soils with high fertility, the majority of upland soils are moderately to strongly acid ultisols that are low in available phosphorus and high in exchangeable aluminum (Garrity and Sajise, 1990). Traditionally, many of these upland soils have been successfully managed through a swidden system of short cropping periods followed by long fallow periods. However, increasing population densities in upland areas have led to a drastic shortening of the fallow period in many locations. This has led to significant and progressive soil degradation.

Although evidence indicates that crop yields can be maintained on these types of soils with the application of high amounts of fertilizer and lime (Sanchez et al., 1982), the cost of these inputs is beyond the reach of most upland farmers. Other related research has been conducted to investigate the possibility of maintaining or restoring soil fertility through the use of organic inputs from green manure crops or from alley cropping. Some studies (Sanchez and Benites, 1987; Craig, 1988; Szott et al., 1991) indicate that the incorporation of a green manure into the crop rotation system can significantly increase cereal crop yields. However, other results from some of these studies (Sanchez and Benites, 1987; Szott et al., 1991) and results from other studies (Garrity, 1991; Evensen et al., 1995) indicate that green manure inputs from hedgerow prunings do not supply crops with adequate quantities of nutrients, especially phosphorus.

An additional problem faced by upland agriculturalists is soil erosion from steeply sloping land. The intense and abundant rainfall in the humid tropics, the steep slopes of many upland fields, and the observed lack of erosion control measures create conditions for the extensive soil erosion, in excess of 200 t/ha/yr, that has been observed from upland fields in the Philippines (Zoleta, 1987; Cruz, W. et al., 1988; Lasmarias et al., 1988; EMB-DENR 1990). The deleterious effects of this erosion on soil fertility and crop productivity have been well documented (Cruz, W., et al., 1988; Lasmarias et al., 1988; El-Swaify, 1992). There is some question as to the actual impact of water runoff and the associated soil erosion from upland fields on downstream water flows and sediment deposition (Hamilton, 1985). Even though the scientific evidence is mixed, the popular perception that erosion from upland fields leads to lowland and near shore sediment deposition has strongly influenced Philippine government policy.

Some Philippine upland dwellers have been able to exploit their location and environmental conditions to enter specific high-value markets (e. g. flowers, certain vegetables) and have been able to employ the necessary chemical inputs (for fertility maintenance) and mechanical inputs (terrace construction for erosion control) to greatly improve their system productivity. However, most other upland dwellers live a marginal existence trapped by poverty. Life expectancies are lower and infant mortality rates are higher than for comparable groups in the lowlands. Upland dwellers often lack access to primary education, health care, and agricultural assistance.

Perceptions of upland management activities

In addition to the difficulties associated with survival in the uplands. Upland residents have also faced and continue to face a series of misperceptions or at least limited perceptions of their activities. Discussion of upland dwellers before the 1960's typically referred to the "evil kaingineros" who were destroying the potentially valuable uplands through indiscriminate slash-and-burn cultivation for agriculture. Anthropological research on actual upland management systems, starting with Conklin's (1957) monograph on the Hanunoo Mangyan people of Mindoro, has served to alter this perception at least for the indigenous upland communities that have been the focus of a large majority of research efforts. Indigenous upland dwellers now gaining respect as skillful managers of their resources even in official government publications (EMB-DENR, 1990; Lucas-Fernan, 1996). However, many planners and policy makers continue to insist that the lowland residents who have migrated into upland areas lack the knowledge and experience necessary to develop sustainable natural resource management systems and therefore often employ inappropriate and destructive practices (Cruz, M. C. J. et al., 1988; Lopez, 1987; EMB-DENR, 1990) such as short-fallow swidden cultivation of cereal crops (maize, upland rice).

Upland management intervention efforts

Given the difficulties faced by upland dwellers and the perceived adverse off-site effects of improper upland land management, two general groups of development strategies are possible: reducing the number of upland dwellers or improving upland systems in order to make better and more sustainable use of marginal areas (Allen, 1993). The Philippine government has tried both of these approaches.

Agricultural development policies for upland areas have historically focused on the extraction of marketable resources (e. g. timber) followed by expansion and intensification of large-scale agricultural enterprises such as ranching and cultivation of commercial export crops such as sugar cane, coconut and abaca (Anderson, 1987). In addition, laws were enacted to prohibit migrant farmers from settling on designated forest lands.

Evaluation of these policies has shown them to be largely unsuccessful. Extensive resource extraction and large-scale land development for export crop cultivation have been linked to severe land degradation and deleterious downstream consequences. In addition, enforcement of laws prohibiting settlement of designated forest lands has proven nearly impossible. The primary option available to potential upland migrants is migration to one of larger cities in search of scarce job opportunities. Current government policy emphasizes labor-intensive industries and encourages industries to relocate into smaller cities throughout the country. However, even if this policy is successful, it is unlikely to create job opportunities in excess of population growth anytime in the near future.

Since efforts to develop large-scale commercial cropping systems and efforts to exclude or to remove people from the uplands have proven unsuccessful, emphasis has shifted to questions of how to best help upland dwellers manage their land-use systems in ways that will ensure long-term sustainability and minimize off-site impacts. This has also been accompanied by the realization that small-scale upland farms provide important benefits to the Philippines as a whole including the cultivation of potential export crops (e. g. coconut, abaca, coffee, rubber) and the cultivation of many important subsistence crops (e. g. corn, cassava, many vegetables).

Since a large majority of the Philippine uplands are under the jurisdiction of the Department of Environment and Natural Resources (DENR), the primary government program currently operating in upland areas is the Integrated Social Forestry Program (ISFP). The ISFP has four broad components: 1) provision of land tenure through renewable 25 year leases, 2) assistance to farmers by providing information on farming technologies, farm inputs and other services, 3) improvement of infrastructure, and 4) facilitation of farmer access to existing government credit programs (Gacoscosim, 1995).

In addition to the government programs, academic institutions and non-government organizations are also active in certain upland areas. The most widely recognized upland development activities are being conducted by the Mag-uugmad Foundation in Cebu and Bohol provinces (with the assistance of World Neighbors, an international NGO), the Mindanao Baptist Rural Life Center (MBLRC) in Davao del Sur province, the Kalahan Educational Foundation in Nueva Viscaya province and the International Institute for Rural Reconstruction (IIRR) in Cavite province.

Research-focused activities are also being conducted by several groups including the Conditions for Biodiversity Maintenance Project (SEARCA and the East-West Center) operating throughout the country, the FAO supported FARM project in Quezon province, ACIAR supported projects conducted by SEARCA in South Cotabato and Rizal provinces, the USAID supported Sustainable Agriculture and Natural Resources Management Cooperative Research Support Program

(SANREM-CRSP) in Misamis Oriental and Bukidnon provinces and ongoing research conducted by Cornell University in Southern Leyte province, as well as activities of at least four international research centers: ICRAF, ICLARM, IRRI and CIP.

In spite of all of these development efforts, there is little evidence that these development activities have led to improvements in the sustainability of upland livelihood systems except in a few specific locations where projects have operated. And, in spite of the extensive research that has been and continues to be conducted in the Philippine uplands there is again little evidence of research results and recommendations being transferred beyond research stations and specific research sites.

Responses to upland problems

Given the lack of success of previous development policies, programs and projects, an alternative way of looking at upland management strategies is necessary. Ruddle and Grandstaff (1978) suggest that there is a need for a shift from a transferential development strategy based on the transfer of technology and ideas to a transformational development strategy. This strategy uses the description and analysis of local knowledge and existing local management as a starting point for the development of policies, programs and projects that will work with local residents to transform their systems into systems that provide better livelihoods for upland residents while helping to preserve valuable upland resources and functions.

Local knowledge

For the purposes of this study, local knowledge is defined as: the knowledge held by upland dwellers about their natural environment and their resource management (including agricultural) practices. It includes "traditional" or "non-western" knowledge, but it also includes local adaptations of "modern" management practices. I have chosen to use the term local knowledge instead of the more common indigenous knowledge to avoid the prevailing association of the term indigenous knowledge with distinct cultural groups.

Numerous studies have documented the extent and variability of local knowledge related to agriculture and resource management in the Philippines including knowledge about agroecological zones (Duhaylungsod, 1991), crop and vegetable varieties (Clawson, 1987); soil and water conservation (Fujisaka, 1989; Ramirez, 1988) and land and soil classification (Fujisaka, 1989; Olofson, 1981b; Wollenberg, 1985). Other studies (Eder, 1981; Fujisaka, 1986; Fujisaka and Capistrano, 1986; Fujisaka and Wollenberg, 1991; Kummer et al., 1994) have discussed the development of successful upland systems which are themselves manifestations of local knowledge.

One key characteristic of local knowledge, particularly in the context of agriculture and natural resource management, is that it has been gained from specific experience. Most local knowledge is not based on the type of theoretical principles that underpin “scientific” knowledge. Instead, it is based on the individual experience of the knowledge holder, on the collective experience of the members of the community, or on a combination of these.

In recent years, there has been an increasing awareness of the extent and potential utility of local knowledge in agricultural development, particularly in the wide variety of diverse environments found in areas like the tropical uplands. In these environments, local knowledge of soil conditions, micro-climates, specific crop varieties and effective management practices provide an immense amount of potentially valuable information that could never be practically collected using traditional scientific methods.

Some proponents of the concept of adaptive management (Allen et al. 1998; Holling et al., 1996) assert that every farm management activity can be productively thought of as a type of experiment. As a consequence, farmer observations of the outcomes associated with different management regimes form an extremely valuable, and currently underutilized, source of knowledge.

However, unlike scientific knowledge which is, at least theoretically, applicable in a broad spatial and temporal context, some attributes of local knowledge may limit its applicability beyond particular places and times. First of all, local knowledge is dynamic because it is based on farmers unique and ongoing experiences and interactions with others and the local environment. Second, local knowledge forms as a part of a broader social, cultural and political context. Third, local knowledge is diverse and often specific to an individual or group (Amihan-Vega, 1993).

Given the strengths of both local knowledge and scientific knowledge, successful description, comprehension and discussion of the upland management systems and the sustainability of these systems requires the use of both local and scientific knowledge. This coupling and interaction between knowledge systems provides the greatest opportunity for the development of useful insights toward what constitutes sustainable practices. Local systems that already incorporate sustainable practices can serve as models or at least as starting points for the improvement of other existing systems (Moles, 1989; DeWalt, 1994; Portela, 1994).

Specific study activities

In order to begin the planning process for interventions designed to help improve upland livelihood systems, it is of fundamental importance to understand the present management systems. To this end, the first objective of this study is to describe a range of typical management system used in the Philippine uplands. I identified three typical upland communities and developed descriptions of various management alternatives.

However, given the variety of environmental conditions in upland areas as well as differences between areas related to socio-economic variables such as distance to markets, there are a wide variety of management strategies employed by upland residents. All of these strategies do not have the same impact on household livelihoods or on the upland environment. Therefore, there must be a way to identify a sub-group of "better" strategies that can potentially serve as models for future development efforts. The second objective of the study is to rate the various management systems using the criteria of sustainability. Simply put, the sustainability of a system is a measure of its ability to meet the needs of the system managers on into the future. A more complete definition and background information on sustainability are discussed in the next chapter.

Even though an assessment of the sustainability of various management alternatives is informative and useful, the development of viable improvements to existing strategies requires a better understanding of why different residents have chosen to use different management strategies. Therefore, the third objective of this study is to develop models of decision making in order to identify some of the important factors that influence decision making regarding management alternatives, potential constraints to management alternatives, and potential intervention points.

Organization of the dissertation

The remainder of the dissertation will be organized as follows. The next chapter (Chapter 2) covers a review of the main ideas underlying the analysis including the concept of sustainability. It also presents a review of the agroecosystem analysis methodology that will be used in the sustainability assessment and of the principles behind modeling decision making. This is followed by a discussion of the overall study design including site selection and data collection methods (Chapter 3).

The next chapter (Chapter 4) identifies the specific study locations, discusses the data available at each site and provides background information on the general environmental, bio-physical, and socio-economic characteristics of each site. It also contains brief descriptions of the "typical" household management systems in each site that will be used as a basis for subsequent analysis. More detailed descriptions of these household management systems are found in Appendix 1. Chapter 5 presents and discusses the results of the sustainability assessment of various upland management systems based on the agroecosystem analysis properties. Sustainability is assessed at both the community and individual household level. The subsequent chapter (Chapter 6) presents and discusses models of land management decision making for the three communities and also presents and discusses several specific household case studies that illustrate management systems of special interest. The final chapter (Chapter 7) contains a summary of the study results, discussion and conclusions, a discussion of future trends in the three study communities, and recommendations targeted toward both further research and toward policy, program and project development.

Chapter 2
Important Concepts

Introduction

This chapter provides definitions and background information on the important concepts used in this analysis. Since the central focus of the analysis is on the concept of sustainability, the chapter begins with a definition of sustainability and with definitions of other important concepts of systems, models, households and livelihoods. This is followed by a brief discussion of the range of criteria used to identify and assess the sustainability of agricultural and natural resource management systems, a more detailed discussion of the agroecosystem analysis criteria and methodology, and examples of how other studies have applied agroecosystem analysis to sustainability issues. The chapter concludes with a review of the theory related to the evolution and adaptation of agricultural systems and examples of how other researchers have described changes in system management strategies.

Sustainability

Sustainability is often referred to as a "God, motherhood and apple pie" concept, that is, it is perceived as such a positive thing that everyone is certainly for it. However, pinning down an exact definition of sustainability in the field of land management systems, or anywhere else for that matter, is very difficult. In this section, I will develop a working definition of sustainability that forms the basis for the remainder of this study.

Working definition of sustainability

Perhaps the most appropriate place to start when attempting to define sustainability is in the dictionary; however, the word sustainability is not even listed in many dictionaries. Webster's New World Dictionary (Guralnik, 1979) offers the following definition of the verb to sustain: "to keep in existence; maintain or prolong" (p. 603). From this, a definition of sustainability follows: the ability to remain in existence or to be maintained. Although this definition may initially seem to be simplistic, Bawden (1991a) has suggested a very similar definition that I will use as the basis of this analysis.

Definition: Sustainability (of anything) is simply the ability to persist.

The major strength of this definition is that it does not, it itself, suggest specific indicators of sustainability that are assumed to apply in any and all situations, instead it provides a starting point for more detailed analysis. Bawden (1991a) suggests that when looking at the sustainability of systems where human beings are involved, two fundamental questions need to be asked: "What do we want to persist?" and "How do we learn to persist?" In the context of this study, I will also add a third, similar question: "How do we identify persistence?".

All of these questions, particularly the first two, cannot be answered within the context of scientific inquiry but require personal and social decisions about ethics and aesthetics (Bawden, 1991a) As a consequence, the persistence of a system is an ever-changing phenomena and in order to assess the persistence of a system at any given time, it is necessary to understand not only the biological processes but also the local values that have led to the development and maintenance of that particular system. The next sections of this review will be structured around these three fundamental questions.

What do we want to persist?

The first question asked by Bawden when discussing the concept of sustainability is "What do we want to persist?". This question is fundamental because sustainability must be evaluated within some context — nothing is inherently sustainable or unsustainable in a vacuum. In order to answer this question and thereby define the focus of this study, it is necessary to define what is meant by a system and to discuss some of the potential issues associated with defining an appropriate system on which to focus this analysis.

Systems

The context most often used to assess sustainability is the context of a system. Ackoff provides one of the most general definitions of a system: "Any entity, conceptual or physical, which consists of interdependent parts" (Ackoff, 1960, p. 1). This definition highlights three common attributes of any system: 1) It must be a definable entity with a boundary so that there is a way to specify what is inside or outside of the system; 2) It must have two or more components, and 3) There must be some interaction between the components. An additional property of most systems is that they can be productively thought of as being arranged in a hierarchical fashion.

Systems have been used as a management and analysis tool in many fields including the engineering (e.g. mechanical systems), the biological sciences (e.g. the human nervous system) and the natural sciences (e.g. a forest ecosystem).

Hierarchies

System components are often productively thought of as being arranged in hierarchies, that is, certain components operate on a higher level (e. g. longer time duration or larger spatial extent) (Simon, 1962; Holling et al. 1996). In ecological systems, higher level components tend to govern the long-term behavior of the system, while lower level components tend to govern short-term system behavior (Holling et al., 1996).

Another central idea of hierarchical systems is that each level (holon) has a double nature, it is both made up of smaller parts and is itself a part of a the next higher level. Therefore, a holon always has at least two different and often conflicting goals. On its own level, it needs to maintain its structure and to successfully compete with other holons at the same level. However, its actions are constrained by the control exerted by the next higher level (Giampietro, 1994).

The third major characteristic of hierarchical systems is that, at least for analytical purposes, most can be treated as decomposable. That is, it is possible to isolate and describe one particular part of the system independent of the rest of the system (Simon, 1962). In order to have a description that is effective for dealing with a problem on a particular level, three conditions are necessary: 1. the time and space scale should be compatible with the parameters to be observed and studied, 2. the changes in the higher level should be slow enough to not affect the observations, and 3. the changes on the lower level should be small enough that they are also negligible (Giampietro, 1994).

Models

When discussing concepts such as the sustainability of a system, models are often used. A model can be defined as a simplified representation of an actual situation. Models can take forms ranging from purely mental constructs to simple box-and-line diagrams to elaborate computer-based simulations. Checkland (1991) has suggested that the word holon should be used to denote the conceptual entity (or model) and that the word system be reserved for physical entities. However this has not gained popular acceptance and so I will maintain the common convention of using the word system to refer to both model and phenomenon.

In any discussion of models, it is important to remember that all models are necessarily incomplete representations of natural phenomena. In Bawden's terms "all maps and models are wrong, some are more useful than others" (Bawden, 1991a, p. 41). However, although the world is extremely complex, there is ample evidence of both natural and man-made order (Woodburn, 1988; Stewart and Cohen, 1994). Systems as models provide one way to better understand the degree of complexity in a situation and to suggest ways to change or improve the situation (Woodburn, 1988).

Human activity systems

A growing amount of research has been conducted on systems that involve a human component. These systems have been referred to using a variety of terms including: human activity systems (Checkland, 1991 and 1994), purposeful systems (Ackoff and Emery, 1972), and human systems (Allen, 1994). The belief that human activity systems are fundamentally different from other systems stems from the premise that people perceive reality selectively and make judgements about it. Both perceptions and judgements are based on standards of fact and value (what is and what is good) (Checkland, 1994). But, as these standards are applied they may change and as the situation changes, perceptions and beliefs also may change through the learning process.

This has several implications. First of all, the same system may be perceived differently by different participants who have different types and levels of knowledge; or by the same participant at different times, since learning will have taken place between observations. Secondly, these systems are always changing, and any description and analysis of the system (or a model of the system) at one time will be only a snapshot of a changing entity. Thirdly, in this type of system, the behavior of the "average" component may provide very little information about the long-term behavior of the whole system (Allen, 1994). For example innovators and unusual members of a system may provide the necessary knowledge or skills that allow the system as a whole to adapt to a changing external environment.

Systems in agriculture

There have been many attempts to apply systems concepts to the study and analysis of agriculture. In general, these applications can be divided into two broad groups: those that consider agriculture as a physical system and those that consider agriculture as a human activity system.

Agriculture as a natural system

Most of the best known work on systems applications in agriculture has treated agriculture as a physical system or set of physical systems. There have been several books written (e.g. Dent and Anderson, 1971; Spedding, 1988) and international conferences held concerning the use of systems approaches in agriculture (e.g. Remenyi, 1985; Penning de Vries et al., 1993; Kropff et al., 1997; Teng et al., 1997). The majority of this work has focused on systems associated with one crop and so is often referred to as cropping systems research (Hoque, 1984). Limitations of this approach in explaining the situation primarily of small-scale farmers in the countries of the South led other researchers to expand the boundaries of the study system to include the entire farm and led to the development of farming systems research. Other important systems-based work has been and continues to be conducted in other areas including pest and weed management; however, I will only briefly discuss cropping systems research and farming systems research here.

Cropping systems

Cropping systems research has typically concentrated on a narrowly defined system related to the management of a specific crop. Typical cropping systems studies compare different varieties of an individual crop or different crop management strategies such as fertilizer or pesticide applications. Cropping systems research practitioners assume, either explicitly or implicitly, that most problem situations in agricultural can best be solved by focusing specifically one particular crop or at most a few crops. Most cropping systems research has been confined to the biophysical aspects of crop growth and management; however, cropping systems researchers are increasingly considering other issues, particularly the economics of crop production.

Farming systems

A broader definition of the system of interest is used by practitioners of farming systems research and analysis. The farming system or farm household system, defined by Shaner, Philipp and Schmehl (1982) as: "a unique and reasonably stable arrangement of farming enterprises that the household manages according to well-defined practices in response to the physical, biological and socioeconomic environments and in accordance with the household's goals, preferences and resources" (p. 16), has become the focus of extensive work in both research and development (Shaner et al., 1982: FAO, 1989).

As is apparent from the definition above, farming systems research considers a broader focus than cropping systems research. In addition, since its earliest conceptions, farming systems research has explicitly considered household economic and labor relations. However, farming systems research has still been largely confined to the consideration of agricultural enterprises, generally defined to include the management of plants and livestock on the land holdings managed by the household.

Agriculture as a human activity system

Although farming systems researchers often take a broad view of what should be included in a farming system, another segment of the research and development community suggests that agriculture is better conceptualized and understood as a particular type of human activity system (Wilson and Morren, 1990; Bawden, 1991b). At least three different conceptualizations of this idea have been suggested: the agroecosystem, the coupled ecosystem - social system and the household livelihood system.

The agroecosystem

An agroecosystem can be defined as: a natural ecosystem which has been modified for the purpose of producing food, fiber or other agricultural products (modified from Patanothai, 1991). As originally conceptualized by Conway (1986), an agroecosystem includes both the agricultural ecosystem managed by the household or alternate management unit and the farm manager(s) themselves. Therefore, activities of the human components of the agroecosystem, including decision making, resource allocation and interactions with others outside the system are seen as activities taking place within the agroecosystem. When agroecosystem is used in this context, it becomes a very close parallel to the definition presented above for a livelihood system.

The coupled ecological - social systems

An alternative to Conway's conception of agroecosystems has been proposed by some human ecology researchers (Rambo, 1984; Röling, 1994). They suggest that it is more productive to consider land management activities as the result of two separate, interacting or coupled systems. These systems are a social or management system comprised of the human component and an agroecosystem comprised of the biological and environmental components. These systems continuously interact through the flow of materials and information between them as exemplified by a process of manager observation of the agroecosystem leading to decision-making regarding management activities leading to the management activities themselves.

Household livelihood systems

Although the above definitions of agroecosystems and coupled environment - social systems provide good starting points, agricultural activities are often only one part of the broad range of activities practiced by tropical upland dwellers (Siebert and Belsky, 1985; Conway and Barbier, 1988; Hecht et al., 1988). Although non-agricultural activities can be considered under the other two types of analysis, it may be preferable to use a broader concept such as the household livelihood when describing and analyzing these systems.

A household can be defined as: "... a socially recognized domestic group whose members usually share a residence and carry out a range of activities ..." (adapted from Netting 1989) while a livelihood can be defined as: "... the capabilities, assets (stores, resources, claims, and access) and activities required for a means of living..."(Chambers and Conway, 1992, p. 7). Therefore for this study, a household livelihood system will be defined as:

> **The knowledge, skills and assets possessed and employed by a household including the natural environment and the activities conducted by that household to address the needs and goals of its members.**

Summary

The remainder of this analysis will focus on the household livelihood system as the answer to the question posed at the beginning of this section "What do we want to persist?". Using the household livelihood system as the basis for analysis has four major advantages: 1) It places the primary focus of analysis at the household level where most decisions directly impacting local land management are made (Axinn and Axinn, 1984; Netting, 1989; Wilk, 1989; Castillo, 1993). 2) It explicitly includes consideration of household knowledge, skills and assets. 3) It explicitly includes all the productive activities of the household in the analysis, not just those associated with agriculture. 4) It facilitates the use of the agroecosystem analysis methodology (Conway, 1986) for the assessment and comparison of management systems.

However, even though the focus of this analysis will be at the household level, it is important to remember that households do not exist in a vacuum and therefore livelihood system sustainability cannot be assessed by only considering the system at this level. As a consequence, this analysis will include consideration of attributes at both higher (community) and lower (enterprise) hierarchical levels where they provide additional information and insight..

How do we identify persistence?

Having provided an answer to the question of "What do we want to persist?" for this study, I will move on to the second question "How do we identify persistence?" It is relatively simple, in hindsight, to identify those systems that have persisted. However, this is often not a particularly useful guide for contemporary activities. Therefore, it is necessary to develop a set of properties and a methodology for assessing the likely sustainability of various existing systems.

In this study, I will use the methodological framework of agroecosystem analysis (AEA) to assess and analyze system sustainability. However, before describing AEA in detail, I will provide some background on the antecedents and historical development of AEA. This will be followed by a description of the AEA properties and methods. This section will conclude with some examples of how the AEA principles and framework have been used by other researchers to investigate system sustainability.

Context and development of agroecosystem analysis

There are three primary areas of inquiry that form the basis for the framework that is now referred to as agroecosystem analysis. The first of these is sustainable agriculture, specifically the development of the field of agroecology, the second is international agricultural development, and the third is human ecology. Agroecosystem analysis has come about from a blending of philosophies, characteristics and methods from all of these fields and combined them in order to provide a way to better understand agricultural and land management systems primarily in the countries of the South.

Sustainable agriculture

In the ever increasing literature on sustainable agriculture, several definitions of the concept have been offered. One of the most widely accepted definitions was offered by Harwood who defined sustainable agriculture as: "an agriculture than can evolve indefinitely toward greater human utility, greater efficiency of resource use, and a balance with the environment that is favorable both to humans and to most other species" (Harwood 1990, p. 4).

This definition illustrates the multifaceted nature of sustainable agriculture. Operating in a more theoretical context, Douglass (1985) and Smit and Smithers (1993) have found it useful to divide the concept of sustainable agriculture into three general schools of thought. The first school conceptualizes agricultural sustainability in terms of the maintenance of productivity to supply enough food to meet everyone's demand. In contrast, the second school regards agricultural sustainability as an ecological phenomenon. The key premise of this group is that agricultural production must not deplete the renewable resource base. The third school pays more attention to the effects of agricultural systems on community life. The primary goal of this school is not ecological, but is an agriculture that promotes a vital, coherent rural culture. Douglass (1985) goes on to state that all three of these aspects of sustainability are desirable; however, real world conditions may necessitate significant trade-offs between them.

One major component of the second school of agriculture sustainability is the field of agroecology. As defined by Altieri (1987) agroecology is:

> "a theoretical framework aimed at understanding agricultural processes in the broadest manner. The agroecological approach regards farm systems as the fundamental units of study, and, in these systems, mineral cycles, energy transformations, biological processes and socioeconomic relationships are investigated and analyzed as a whole. (p. xiv)"

As is evident in the above definition, agroecology takes many of its fundamental concepts from ecology. In parallel with the sustainable agriculture movement, agroecology can be seen as an attempt to better understand agricultural systems with a strong focus on minimizing the negative effects of agriculture on the environment. Its development has also been strongly influenced by the sustainable agriculture movement, systems theory and by the long history of research that has attempted to make sense of the numerous factors that affect agriculture (Hecht, 1987).

International agricultural development

International agricultural development activities, particularly since the 1960's have also played an important role in the development of agroecosystems analysis. Much of the early work in agricultural development was conducted using what is often referred to as the transfer of technology (TOT) model. Proponents of the TOT model of development generally hold several basic beliefs: 1) The way to improve the livelihoods of the poor residents of the "developing" countries was to increase agricultural production. 2) The way to increase production was to transfer technologies and technology packages developed by scientists largely from the countries of the North (e.g. new crop varieties, management practices including fertilizer and pesticide use). 3) Technologies were location and scale neutral.

The most widely visible manifestation of the TOT model was the green revolution of the 1960's. The green revolution focused on three interrelated actions: 1) breeding programs for staple cereals that produced new, higher yielding varieties, 2) organization and distribution of agricultural inputs such as fertilizer, pesticides and irrigation and 3) implementation of these innovations in the most favorable agroclimatic regions (Conway and Barbier, 1988).

Proponents of the TOT model as epitomized by the green revolution argue that it was very successful, particularly in terms of increasing agricultural productivity (mainly cereal production) to meet and often exceed the needs of rapidly growing populations in many countries (Pinstrup-Andersen and Hazell, 1985). However, critics have pointed out that these rapid increases in productivity have come with significant potential and actual problems. These include: increasing dependence on chemical inputs (Conway and Barbier, 1988), long term deleterious changes in soil properties (Cassman and Pingali, 1994), and potentially adverse impacts on animal and human health (Pingali et al., 1994).

In addition, while the blanket prescriptions of the TOT model may have been appropriate for the relatively homogenous lowland areas in many countries, they were largely unsuccessful for residents of other, much more varied, environments such as rainfed lowlands and uplands (Chambers, 1990). These areas are home to large numbers of people in most South and Southeast Asian countries and are often much more easily degraded through the use of inappropriate agricultural management practices.

The set of properties and procedures now known as agroecosystem analysis (AEA) was suggested by Conway (1986) as a way to better describe and understand agroecosystems as a way to improve the process and outcomes of agricultural development activities and avoid the problems of the transfer-of-technology model, particularly in these non-irrigated areas. In contrast to other development alternatives that developed around the same time, primarily farming systems research and development, AEA has been directed toward the definition and description of the principles which underlie any ecologically successful and sustainable use of the environment, not the development and dissemination of technologies. It also explicitly recognizes that valid local practices may exist and seeks to help farmers identify the most sustainable (from an ecological perspective) practices and recognizes that change is an inherent property of all persistent ecological systems (Conway, 1986).

Human ecology

The third background source for what is now referred to as agroecosystem analysis is the area of human ecology. As Rambo and Sajise (1984) state, human ecology is a perspective for looking at systems, not a discipline in and of itself. As a perspective it has four major features: 1) it employs a systems view of both human society and nature; 2) it describes both the internal behavior of social and ecological systems and their interactions; 3) it organizes systems into networks and hierarchies; and 4) it recognizes the dynamics of system change.

The primary contribution of the human ecology perspective to Conway's original development of agroecosystem analysis has been to increase the awareness of the need to include the social system and the interactions between the social and ecological system in any assessment of an agricultural system. Although there has been no resolution of the debate between the proponents of an inclusive agroecosystem that internalizes the social system and the proponents of a coupled system approach, In practice, the agroecosystem analysis properties and methods outlined in the next section have been robust enough to satisfy both groups.

The agroecosystem analysis (AEA) framework

All three of the sources discussed above influenced and continue to influence the ongoing development and refinement of the agroecosystem analysis framework. In this section, I will discuss the major components of the AEA framework: the AEA properties and the most common AEA methods. This is followed by a discussion of the likely impact of various AEA properties on overall system sustainability. Potential tradeoffs between system properties are then discussed and the section concludes with some examples of the use of AEA.

AEA properties

As originally described by Conway (1986), AEA considered four system properties: productivity, the net increment in valued product per unity of resource; stability, the degree to which productivity remains constant in spite of normal, small scale fluctuations in environmental variables; sustainability, the ability of a system to maintain its productivity when subject to stress or perturbation; and equitability, how evenly the productivity of the system is distributed among its human beneficiaries.

Input from anthropologists, particularly from the areas of human ecology and ethnology has resulted in the inclusion of two more properties: autonomy, agroecosystem self-sufficiency or self-determination; and solidarity, social control over individual actions (Marten, 1988). Further work in the area, mainly conducted by researchers in the Southeast Asian Universities Agroecosystem Network (SUAN) has resulted in the inclusion of diversity, the number of different components of the same basic type within a system, and adaptability, the ability of the system to respond to change to ensure its continuing survival, as agroecosystem properties (Patanothai, 1991).

In Conway's original formulation of the AEA concept, sustainability was defined as a property of agroecosystems. However, there are two significantly different phenomena being discussed as having an impact on system sustainability, stresses and perturbations. A stress, as defined by Conway, is a long-term decrease in some component necessary for the perpetuation of the system (e.g. gradual loss of soil fertility over time or gradual depletion of a freshwater aquifer). In contrast, a perturbation or shock is a specific event or occurrence that strongly and adversely impacts the agroecosystem (e.g. a major hurricane or the end of government price subsidies from one year to the next).

Uehara (1994) suggested that it may be beneficial to look at sustainability as an emergent property of the entire agroecosystem. There are at least three advantages to this approach (Uehara, 1994). They are: sustainability is readily seen as the result of trade-offs among systems properties; productivity is seen as an integral part of sustainability; and sustainability is expressed as an outgrowth of distinct properties which can be quantified and measured. In order to avoid confusion, I will provide different names for the two components of Conway's sustainability. I will refer to the ability of a system to respond to stress as **maintenance** and the ability of the system to respond to perturbation as **resilience**.

AEA methods

In his description of AEA methodology, Conway (1986) asserts that the analysis should initially concentrate on identifying the components of the system, their relationships (spatial, temporal) and the flows of matter, energy and information between them. Once the components, relationships and flows are identified, the analyst can employ pattern analysis to attempt to quantify and qualify the nine major agroecosystem properties (productivity, stability, maintenance, resilience, equitability, autonomy, solidarity, diversity and adaptability). This analysis can also be used to identify problems and constraints faced by the system and the interactions between the system in question and other systems at higher and lower levels. Subsequently, the analyst is encouraged to investigate the apparent trade-offs between the various system properties. This analysis of trade-offs can serve to infer farmer priorities which can be checked against stated farmer preferences and which can serve as a basis for suggested improvements to the system.

Expected impacts of agroecosystem properties on sustainability

Productivity

Maintenance of sufficient productivity is nearly universally believed to be necessary for the development of a sustainable agricultural-based household livelihood system. However, there are a large number of definitions of what constitutes productivity and what is meant by sufficient. In general, productivity can be thought of as a comparison between some measure of the amount of production of a useable and desirable good and some measure of the level of resources used to produce that good. The most widely used measure of productivity in agriculture is yield per area (usually kg/ha). However, productivity can also be expressed as yield per unit of labor input or yield per unit of cash investment (Altieri, 1987). In subsistence-based systems, maintenance of sufficient productivity usually means that the system is able to continue to produce sufficient food to meet household consumption needs.

The primary criticism of food self-sufficiency as a measure of sustainable productivity is that research has shown that most rural and particularly upland households are not completely self-sufficient. In fact, they may need significant levels of cash income to meet their needs and goals (e.g. money to pay for children's schooling). Therefore, the sustainable level of productivity in these systems must include maintenance of the ability to generate sufficient output that can be converted to cash. Given this situation, many researchers, led by the economists, have suggested that profit or net income (income minus production costs) is the most appropriate measure of productivity. Related measures include partial budget analysis, where only the change in net income resulting from changes in one particular management strategy are considered, and calculations of the internal rate of return, which uses a ratio of income to costs instead of simple subtraction. Other researchers (Harrington, 1992; Lynam and Herdt, 1992; Ehui and Spencer, 1993) have suggested total factor productivity (TFP) (defined as the value of all system outputs divided by the value of all system inputs), as a more appropriate measure. In all of these cases, a sustainable system is one that, in most years, is able to break even or has a monetary surplus after all expenses are paid.

Cash-based measures of sustainable productivity are not without problems. First of all, it may be difficult to obtain information on the actual prices paid or received by the manager for inputs and outputs. This is especially true for estimating the value of output to be sold sometime in the future (Gittinger, 1982). In addition, dealing with inputs and outputs that are not easily quantified, such as family labor or use of crop residues for animal feed, can be difficult in a money-based analysis and requires the use of a "shadow" wage rate or price. A variety of methods exist to help researchers estimate these "shadow" quantities; however, any analysis remains subject to changes in these estimates (Gittinger, 1982).

Stability

Stability has been widely held to be synonymous with sustainability in both natural ecological systems (Odum, 1975) and agroecological systems (Harwood, 1979; Altieri, 1987; Gleissman, 1990). A sustainable agroecosystem is generally conceived as one that is able to maintain a stable level of production through the use of species and management practices that are adapted to the existing environment.

Maintenance

In this analysis I am using the term maintenance to describe system response to a relatively continuous stress. In general, a system's ability to respond to stress is seen as highly related to system sustainability. When discussing sustainable agriculture livelihood systems, authors often refer to the use of practices that reduce the amount of certain stresses. For example, effective soil erosion control measures can reduce the amount of soil loss and decrease the stress of soil degradation (Altieri, 1987; O'Connell, 1991; Taylor et al., 1993). Other maintenance enhancing activities include the use of green manures, animal manures and crop rotations with legumes to ameliorate the stress of declining soil fertility (Altieri, 1987; O'Connell, 1991; Taylor et al., 1993; Bird et al., 1995). Maintenance enhancing activities do not necessary have to originate within the agricultural component of the household livelihood system. For example, chemical fertilizers can be purchased and used to maintain soil fertility levels.

Resilience

In Conway's original description of the AEA framework, sustainability was synonymous with what I refer to here as resilience. Holling also defines the sustainability of an ecological system in terms of resilience: "(sustainability is) the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables" (Holling, 1973, p. 14). In the context of a household livelihood system, high levels of total system resilience are positively related to system sustainability; although this relationship need not necessarily be true for specific system components.

Equitability

Although many of the agroecosystem properties can be related to both natural ecosystems and agroecosystems, equitability is only an important property for systems such as agroecosystems where people are involved. In general, increased equitability is believed to be positively related to increased sustainability of an agroecosystem (Richard Harwood, personal communication). Although equitability can be discussed at within the household (Wilk, 1989), in this study, I will consider equitability at the community level.

True equitability within a community seems to be a rare commodity especially in communities with significant interactions with the outside world. For example, Eder (1982) found significant income and land holding inequality in a migrant community in Palawan, Philippines that had been settled only 30 years previously by migrants with approximately equal resources. There is no consensus regarding whether the often observed decrease in equitability over time in communities has a positive, neutral or negative effect on community sustainability. However, there is a general consensus that situations where the distribution of resources becomes too inequitable may lead to serious intra-community conflicts. For example, the inequitable distribution of land resources in much of the lowland Philippines has been cited as a primary driving force behind the Hukbalahap and New People's Army revolutionary movements from the 1950's to the present day (Reidinger, 1995).

Autonomy

Autonomy is generally believed to have a positive affect on overall systems sustainability. Several researchers (Altieri, 1987; Gleissman, 1990; Bird et al., 1995) cite the use of few off-farm inputs (one measure of autonomy) as an attribute of a more sustainable agriculture and/or more sustainable agroecosystems. Others identify the use of crop rotations (O'Connell, 1991; Bird et al., 1995) and animal and green manures (O'Connell, 1991; Taylor et al., 1993; Bird et al., 1995) as having a positive impact on system sustainability. These practices also generally contribute to increased system autonomy.

However, there may be an optimum level of autonomy. Systems that are highly autonomous may be unable to adapt to changes in their bio-physical or social environment, particularly if these changes are very rapid; whereas systems with more connections to the outside may be more prepared and better able to tap outside resources that may help facilitate their adaptation process (Axinn and Axinn, 1984). One natural example of this can be seen in the significant problems caused by small changes in the isolated Hawaii ecosystem such as the introduction of various plant and animal species.

Solidarity

As in the case of equitability, it makes no sense to talk of solidarity in non-human systems. As with equitability, solidarity is generally believed to be positively related to system sustainability. Intuitively, this makes sense particularly with regard to intra-household relations. Households that are making decisions and acting in concert are likely to be more sustainable than those that do not. However, there is some question of the impact of solidarity at the farm and particularly at the community level. Solidarity is believed to be positively related to sustainability where it provides support and stability for community members and increases community resilience. However, if solidarity is related to a reduction in diversity of actions and knowledge, it may have a negative effect on system sustainability, especially in the face of changes in the larger bio-physical or socio-economic environment.

Diversity

Diversity is the amount of variety that exists in the system under study. Although ecological studies have not shown that more diverse systems are necessarily more stable (Van Voris et al., 1980; Pimm, 1984), resilient or sustainable than less diverse systems, there is a general belief that increasing diversity has a positive impact on farm household system sustainability (Altieri, 1987; Gleissman, 1990; Bird et al., 1995; Olson et al., 1995). This positive impact is attributed to at least three outcomes of increased diversity: 1. Increased diversity of species, enterprises and/or income sources results in a potential reduction in overall risk to the farm household. For example, if one crop is adversely affected by weather or pests, other crops or livestock may be much less affected. This diversity can be spatial, planting different crops in different fields, or temporal, using crop rotations and fallow periods (O'Connell, 1991; Bird et al., 1995; Olson et al., 1995) 2. Increased diversity in the agroecosystem and in the community landscape is believed to reduce the incidence of severe pest outbreaks (Murdoch, 1975; Altieri, 1987) 3. Increased diversity may result in the creation of mutually beneficial linkages between farm enterprises. For example, livestock manure can be used to fertilize crops (O'Connell, 1991; Taylor et al., 1993; Bird et al., 1995; Olson et al., 1995).

Adaptability

In human systems maintenance of adaptability is thought to have a positive impact on system sustainability. It also suggests that adaptive management methods that can change quickly on the basis of changing conditions are best suited for complex ecological systems (Holling et al., 1996). However, adaptability is very difficult to assess except in hindsight. The ability to adapt is usually thought of a being highly correlated with the level of available information. Therefore, level of education, diversity in both the biophysical and socio-economic environments and level of interaction between community members and between members of the community and members of other communities have all been suggested as potential measures.

Interactions between system properties

Given the nine systems properties discussed above, there are over five hundred potential multi-property interactions including thirty-six potential pairs. Many of these interactions are positive, that is, higher levels of one property are generally related to higher levels of other properties. Of primary importance is the complementary interaction between diversity, adaptability and resilience that is believed to contribute to increasing sustainability (Holling et al., 1996). In this section, I will make no attempt to cover all of these interactions, but will instead concentrate on a few interactions where there are commonly perceived to be conflicts between the properties and where trade-offs between properties seem to be necessary.

Productivity-stability

The potential trade-off between productivity and stability was first cited by Conway (1986) in his initial discussion of agroecosystems analysis. He asserted that their was likely to be a negative relationship between the level of productivity and the consistency of that productivity. Specifically, he argued that the factors, particularly management practices, that were necessary to produce the highest levels of productivity (e.g. monocultures, improved varieties) were also likely to make the system more sensitive to small disturbances in the environment and therefore less stable.

Two Argentinian researchers (Virlizzo and Roberto, 1998) found some evidence of this trade-off in their analysis of large cattle and crop operations in the Argentinian pampas; however their findings were somewhat compromised by the positive impact that system diversity was shown to have on both productivity and stability (Virlizzo and Roberto, 1989 and 1998). The potential role of diversity in increasing the magnitude of both properties has also been posited by Gleissman (1990) to be one of the potential benefits of tropical polycultures.

Productivity-maintenance-autonomy

A similar argument can be made related to the relationship between productivity and maintenance. Particularly in the short term, those practices and activities that produce the most yield are also likely to place the most stress on the system and to lower its ability to maintain itself. However, system maintenance can still remain high if inputs can be provided from the outside (e.g. chemical fertilizer). This illustrates a potentially powerful three-way relationship between productivity, maintenance and autonomy.

At the household level, high maintenance, especially when considered from a largely environmental point of view, may not be the only way to increase the level of system sustainability. For example, a land-managing household may choose to over exploit resources (e.g. soil, natural products) in order to generate cash for their children's education. Although one set of system activities has a low level of maintenance, the sustainability of the household may be enhanced because education will allow children to get salary jobs in the government or private sector that will provide the household with a better livelihood than they currently obtain with agriculture.

Stability-resilience

Some recent analysis (Holling et al., 1996) expanding on ideas from evolution, chaos theory and complex system dynamics, suggests that, although stability may be positively related to sustainability over the short term, systems that are very stable under one set of conditions may not be sustainable if these conditions change, especially if the change occurs rapidly. This is supported by evidence from some studies of natural ecosystems (Pimm, 1984). As a consequence, an unstable system with large fluctuations may be better able to persist over time than a narrowly adapted by stable system (Holling, 1973).

Although Holling and his colleagues (1996) have applied these ideas to human activity systems largely concerned with the management of natural resources, it is unclear whether the trade off applies in the small-scale human activity systems discussed in this study. It seems to depend on how stability is achieved. Household livelihood systems that achieve at least short-term stability through the use of a few tried and true practices and activities that are well adapted to a specific set of environmental and social conditions, would seem to be potentially less resilient to major changes that strongly affect one or more of these basic activities.

Autonomy-resilience

As mentioned in the section describing the property, there are potential conflicts between high levels of autonomy and several other properties including resilience. Although systems with high levels of autonomy are generally believed to be more stable, particularly in the short term, their relative lack of connections with the outside environment may tend to make them more sensitive to extra-system perturbations. They will have lower resilience.

Autonomy-adaptability

A similar argument can be made for the relationship between autonomy and adaptability. Since the availability of information is believed to be an integral part of adaptability, very high levels of autonomy may have a negative effect on adaptability through restricting the flow of information into and out of the system.

Examples using AEA properties and methods

There is steadily expanding body of literature related to agroecosystem analysis. This review will make no attempt to cover the entire breadth or depth of the work in the field. Instead, I will concentrate on the smaller set of studies that have been conducted on upland management systems in SE Asia and on other natural resource management systems, including uplands, in the Philippines.

Much of the agroecosystem analysis work in Southeast Asia has been conducted by members of the Southeast Asian Universities Agroecosystem Network (SUAN) headquartered at Khon Kaen University in Thailand. Proceedings from several SUAN Symposia in 1983 (Soemarwoto and Rambo, 1987), 1985 (Sajise and Rambo, 1985), 1986 (Rerkasem and Rambo, 1988) and 1988 (Charoenwatana and Rambo, 1988) have been published and include analyses of both lowland and upland systems. Specific analyses from these proceedings that are more closely related to this research will be discussed later in this section. Other studies have been conducted in upland areas in Indonesia (KEPAS, 1985), Vietnam (Le et al., 1990) and Laos (Gillogy et al., 1990; SUAN, 1991).

In the Philippines much of the work in agroecosystem analysis has been conducted by staff or collaborators with the Institute of Environmental Science and Management (IESAM) at the University of the Philippines at Los Baños. Recent study sites include the Makiling Forest Reserve (Cruz et al., 1991) and selected sites in Ifugao Province (Guy, 1995). Other study sites include Lake Buhi in Bicol Province (Conway et al., 1989) and several barangays in Cotabato Province (SERC, 1990).

In spite of the significant number of agroecosystem analyses that have been conducted and published within the last ten years, there have been very few attempts to use the framework to assess the sustainability of agroecosystems and agroecosystem management strategies beyond the limited conception of sustainability suggested by Conway in his original formulation of the framework and subsequently adopted by SUAN. Since a significant component of my proposed research is to apply the AEA framework to sustainability assessment in upland systems, I will highlight and evaluate three previous attempts to apply this methodology (Subhadhira et al., 1988; Nuberg et al., 1994; Wenger 1997)

Ban Hin Lad, Thailand

The first research discussed in this section is a study conducted by Subhadhira and colleagues (1988) in the Ban Hin Lad area of Northeast Thailand. In this study, they attempted to assess the changes in six agroecosystem criteria (productivity, stability, sustainability, autonomy, solidarity and equity) over the course of 100 years of settlement. They did not attempt to address sustainability on the basis of individual farms, but concentrated on the overall conditions in the village area.

The researchers indicated that they lacked the data necessary to assess system productivity as a whole but that they were able to assess productivity for individual crops. They used several measures to assess crop productivity including the gross marginal product (GMP, the sum of all output values minus the sum of all variable costs), the GMP per hectare, and the GMP per unit of cash input. In addition, they also attempted to assess the energy efficiency of production (defined as the caloric value of all inputs divided by the caloric value of all outputs). From these analyses, they were able to determine that the production of cassava had the highest GMP per hectare; but the production of rice had the highest energy efficiency.

The researchers also attempted to assess system stability and sustainability but were hampered by the lack of available data. Based on observations and inferences, they estimated that system stability had varied significantly over the 100 year history of the area but was currently at a reasonably high level due primarily to village exchange systems and to the development of more extensive irrigation which had stabilized rice production levels. They also made some observations about system sustainability in response to three particular disturbances. Both the cotton cultivation and native pig raising systems in this area collapsed in the face of outside disturbances (declining outside demand for cotton and native pigs); however, local chicken populations were sustained through several serious disease outbreaks.

In the remainder of their analysis, the authors attempted to address the trends in autonomy, solidarity and equity in the Ban Hin Lad system. Although they lacked quantitative historical data, qualitative evidence indicates that system autonomy had decreased through time. Cultivation practices had shifted from a primarily subsistence focus to an emphasis on cash crops. This had increased system dependence on external markets for both inputs and outputs.

The situation with respect to solidarity was more mixed. The researchers indicated evidence of a decline in solidarity including much less use of exchange labor and the cessation of various community rituals and ceremonies. However, they observed some evidence of continued solidarity including farmer-to-farmer redistribution of rice seedlings during times of drought and of chickens after disease outbreaks.

With respect to equitability, the researchers were able to provide a significant amount of quantitative data to indicate that the present situation did not show an equitable distribution of land, assets, or income. Based on historical data, they concluded that the present equitability was much less than past levels and was continuing to decrease.

Uvan uplands, Sri Lanka

The second study that explicitly uses agroecosystem criteria was conducted in an upland area in part of Uva Province, Sri Lanka by Nuberg, Evans and Senayake (1994). In this study, they attempted to address the future of a traditional forest garden system of cultivation in an upland area undergoing considerable land use changes. They used the criteria of productivity (both monetary and labor), stability, sustainability (defined biologically as degree of soil degradation and maintenance of biodiversity), equitability, and autonomy (both economic and environmental) to rate and compare the various land management systems present in the area (forest gardens, market gardens, tea cultivation, pine plantation forest and eucalyptus plantation forest).

All of these criteria were evaluated on a qualitative basis for the situation at the present time. The various criteria for each system were then rated on a five-point scale from very low to very high. The traditional forest garden was rated high or very high on all the criteria used but score low on the criteria of land and labor productivity. In contrast both market gardens and smallholder tea cultivation scored moderate to high on the productivity criteria, but lower on stability, sustainability, equitability and autonomy.

The authors then attempted to reconcile these ratings with observations of current land use patterns. At the time of the study, the cultivation and maintenance of forest gardens was declining sharply, largely at the expense of expanding market garden and smallholder tea cultivation operations. From the results of the agroecosystem analysis, this seemed to indicate that local farmers were placing a higher value on productivity than on the other system properties although this was not explicitly stated by the researchers.

They suggested that three major higher-level factors were driving farmer decision-making. The first of these was increasing population pressure and population density in upland areas. As a consequence, farmers were unable to afford to reserve scarce land for a forest garden, particularly given that a forest garden may take several years to yield significant amounts of marketable outputs. This was closely related to existing problems with land availability and land tenure arrangements. In addition, the authors asserted that the significant cultural changes now underway in Sri Lanka, primarily the shift to a more commercial-based economy and the acceptance of an increasing number of aspects of western culture, have affected farmer desires for forest gardens. Forest gardens were associated with the traditional way of life and could not provide the cash outputs that may be deemed necessary to participate in an increasingly money-based economic system.

Waiahole Valley, Oahu, Hawaii

The third study was conducted in Hawaii by Michael Wenger (1997). In this study, he explicitly set out to use the agroecosystem properties to assess and evaluate the sustainability of land management in one community on the windward side of the island of Oahu. To this end, he developed a framework for analysis that he names the agroecosystem rating matrix (ARM). This was a matrix with the various hierarchical levels of the system of interest on the vertical axis and the eight agroecosystem properties on the horizontal axis. Each cell contained indicators of system status for each level and property. Indicators were divided into four types: strengths, weaknesses, opportunities and threats. He then used these indicators to develop a combined result of each cell consisting of a level (low, moderate, high) and a future trend (decreasing, stable, increasing).

Wenger then applied the ARM to the specific case study of one farm household, primarily engaged in wetland taro production, in the Waiahole Valley of Windward Oahu. He constructed the ARM using the following levels: taro cultivation (enterprise), farm (farm enterprises only), household (including off-farm), community, watershed and macro (all higher levels). After developing values for each cell of the ARM, he discussed the sustainability of the case study system in light of the matrix values. In this case, the primary threat to sustainability at the lower levels (household, farm and taro) was water availability which was controlled at a higher level (state--macro). He also indicated that high levels of solidarity, especially at the household level, adaptability and diversity suggest that the system was likely to be sustainable.

Overview

Examination of these studies provides some insights into the potential advantages and problems with using AEA criteria to assess system sustainability. All studies illustrated that AEA criteria could be used to present a broad picture of a given situation. This broad picture allows and encourages the researcher to assess a system on several different dimensions. I believe that this provides a much broader base on which to base future development efforts. In addition, they illustrated that it was possible to develop logical assessments of all of these properties, at least on a qualitative scale. The Sri Lankan study (Nuberg, Evans and Senayake 1994) also illustrated how the AEA process can facilitate the identification of the key properties that seemed to be influencing farmer behavior while the Hawaii study (Wenger 1997) illustrated how the entire set of system properties at various levels might be qualitatively synthesized to identify key properties that affect overall sustainability.

However, all studies also illustrated some of the limitations and potential problems with the methodology. As explicitly stated in the Thai study (Subhadhira et al. 1988), long-term quantitative data are scant to non-existent in many areas. This makes assessments of stability and sustainability or resilience necessarily qualitative and based on personal recollections or limited historical records. This may still provide useful information, but, particularly in a research context, it raises significant validity questions. Data limitations also may make it difficult to address long-term trends in other system properties such as productivity, equitability and autonomy.

The Hawaiian study (Wenger 1997) concentrated on qualitative and generally subjective assessments of various properties and was strongly dependent on the author's personal assessment and beliefs. However, study conclusions were discussed with and verified by the case study farm household which strongly increased study validity. This may also illustrate a potentially inherent problem in the use of AEA, that many of the variables are extremely difficult to define and may be open to multiple interpretations.

In addition, both the Sri Lankan (Nuberg, Evans and Senanayake 1994) and Hawaiian (Wenger 1997) studies illustrated the difficulty of combining the agroecosystem properties to develop an assessment of overall sustainability. In both of these studies, the authors did not attempt to quantify sustainability but instead provided only qualitative assessments of sustainability based on the AEA indicators.

How do we learn to persist?

Although the framework discussed in the previous section provides a basis for the assessment of the sustainability of Philippine upland management systems, it does not provide a good answer to Bawden's question of "How do we learn to persist?" Specifically, the agroecosystem analysis framework provides a largely objective or at least outsider determined subjective assessment of a situation. It does not explicitly include potentially important ideas regarding the role of local knowledge and the potential for different conceptions of the situation to be held by outsiders and insiders. It also is structured to assess a given system at one particular point in time and does not include criteria for describing and analyzing the historical and ongoing adaptive development of managed natural systems.

In this section, I will outline the framework that I will use to structure this investigation of how the upland dwellers in this study have learned to persist. The learning cycle proposed by Kolb (1984) is discussed first and forms the background for other areas. This is followed by a discussion of adaptive management, a specific conceptualization of how the learning process can be explicitly incorporated into management activities. The remainder of the section focuses on one specific segment of the learning cycle and the management process, agricultural management decision-making. First, I provide an overview of the major factors believed to influence agricultural decision making. This is followed by a discussion of the decision process that led to the identification of elimination by aspects as the most appropriate basis for decision model development in this study. The section concludes with a discussion of decision trees, a specific type of decision models based on the theory of elimination by aspects.

Learning and management

The management activities associated with any human activity system from the small upland farm to a huge corporation can be thought of as the manifestations of one or more decisions made by the manager or managers of the system. These decisions are not made in a vacuum, but are made in the context of observation of present conditions, knowledge of the system and inputs of other information from both inside and outside the system. In addition, these decisions are the result of the manager's ongoing learning process. Various theories exist as to how humans learn. I will not even attempt to cover the breadth and depth of the field in this review but instead will concentrate one generally accepted and potentially useful framework, the Kolb leaning cycle.

Kolb's learning cycle

The ideas espoused by David Kolb and others are usually referred to as "experiential learning". In his book , Kolb defines learning as: "The process whereby knowledge is created through the transformation of experience" (Kolb, 1984, p. 38). Based on Kolb's work, Bawden (1985) identified three principles of experiential learning: 1) Learning is an active and continuous process whereby persons attempt to make sense out of a constantly changing world; 2) This process demands two pairs of very different activities, participation and reflection, and concrete awareness and abstract thinking; and 3) Learning is a tensely active process driven by conflicts in selecting between these activity pairs.

Kolb (1984) developed a four stage, cyclical model to illustrate the experiential learning process. The four stages he identified were: concrete experience (CE), reflective observation (RO), abstract conceptualization (AC) and active experimentation (AE). Bawden (1985) further expanded the Kolb model and integrated it with a general model of the problem solving process to create the cyclical model shown in Figure 2.1.

Adaptive management

A parallel to Kolb and Bawden's ideas discussed above is found in the ideas that have come to be referred to as adaptive management. Adaptive management originated as a response to the frustration experienced by a group of primarily ecology

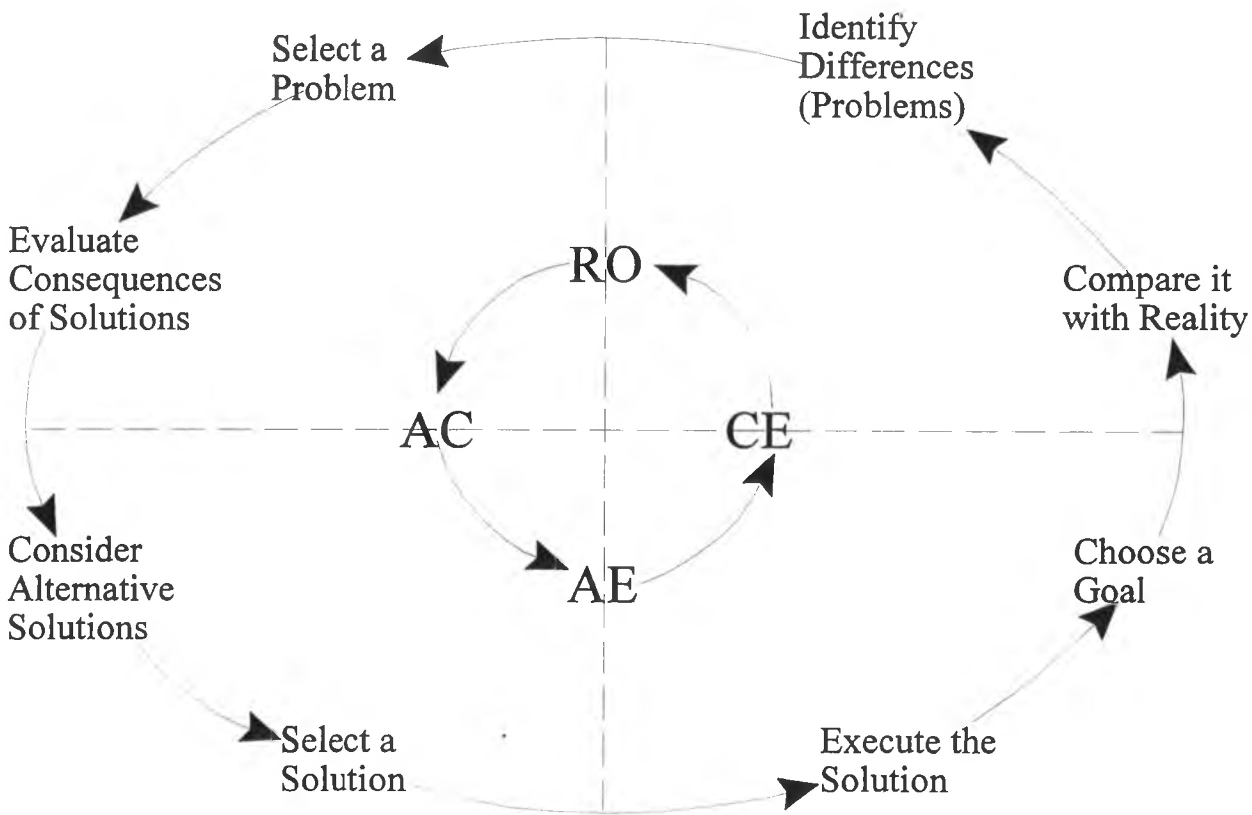


Figure 2.1. Model of the learning and problem solving processes (redrawn from Bawden 1985)

and wildlife researchers in Canada at their ability to provide good information on the impact of proposed strategies for the management of natural resources. Management activities had resulted in unpredicted consequences. These researchers concluded that the complexity of the systems involved precluded them from ever collecting sufficient information to be able to develop accurate models of the total impact of various policies and programs. As a response, they proposed a deliberate procedure that involved the iterative development of models based on the best available information and the development and constant revision of policies based on these continually changing models that are informed by ongoing monitoring of policy impacts (Holling, 1978; Walters, 1986).

Since that time, the procedure has been applied in several contexts including salmon fishery management in the Pacific Northwest (both US and Canada), insect management in the spruce forests of eastern Canada, water management in the Columbia River basin and fisheries management in the Great Lakes (Holling, 1978; Walters, 1986). Although the use of this approach has not been without problems, especially concerning how to incorporate multiple decision makers and multiple views of the management situation, it is still generally held to be a useful approach in natural resources management (McLain and Lee, 1996).

These ideas suggested by Walters (1986) and Holling (1978) are very similar to the cyclic problem solving methodology suggested by Bawden (1985) for agricultural systems. In agriculture and land management, system managers (farmers) are constantly conducting adaptive management activities as they try out new varieties, new cropping and land use patterns and other new management strategies (Allen et al., 1998, Holling et al., 1995). These activities are deliberately used as a way for farmers to identify ways to improve the adaptation of their management systems to changing external circumstances. It has been suggested that every farm management activity can be productively thought of as a type of experiment. As a consequence, farmer observations of the outcomes associated with different management regimes form an extremely valuable, constantly expanding and currently underutilized, source of knowledge.

Systematic research in this area is relatively new. The most extensive work to date has been conducted by Landcare Research in New Zealand. Their work has focused on facilitating the development of an adaptive management process for sheep pasture lands in the high country of South Island. In this effort, they have worked extensively with farmers to identify and collect the existing knowledge and management experience and to develop programs and processes to systematically collect and synthesize new information with a particular focus on the management of *Hieracium*, a highly invasive weed species (Bocsh et al., 1996; Allen, 1997; Allen et al., 1998).

General factors influencing agricultural management decision making

The remainder of this chapter will focus on one aspect of the learning cycle: the selection of a solution to perceived problems. This can be referred to as agricultural management decision making. Although an understanding of the entire learning process will likely be beneficial; the decision making stage, where ideas, perceptions and experience come together and result in a management decision, is of fundamental concern for development workers and policy makers. These management decisions that occur within a specific context (including environmental, social and economic factors) have a pivotal impact on many components of the household livelihood system including: food self-sufficiency, labor availability, availability of surplus to sell in urban markets, and off-farm impacts of improperly applied agricultural chemicals or of soil erosion.

In this initial section, I will discuss some of the general factors that are commonly believed to influence farmer decision making including: local knowledge, the environment, land availability, labor availability, risk and uncertainty, information availability and participation in the cash economy.

Local knowledge

One fundamental factor that influences the decision making process is local knowledge. Local knowledge is of major importance in several stages of the problem solving process illustrated in Figure 2.1 and is integral to the ideas of adaptive management presented above. First and foremost, the vast majority of day-to-day management decisions are made on the basis of local knowledge. Simply put, people act based on what they know and on what has worked in the past. Secondly, new ideas, technologies and practices are evaluated by land managers using criteria based on local knowledge. For example, does the new variety yield better than our present one? or does the new technique give us better returns than our local practices?

Environment

The environment (climate, soils, topography) also has tremendous influence on land management decision making. Simply put, most of the natural components of the agricultural system and as a consequence, most management strategies, such as varietal choice, tillage practice and planting dates, are constrained by the environment, particularly by the prevailing temperature and rainfall regimes (Bayliss-Smith, 1982; Wang and Ray, 1984). Considerable investment in agricultural development has gone toward attempts to ameliorate environmental constraints. For example, irrigation systems and tile drainage systems have been constructed to address moisture constraints, windbreaks have been constructed to ameliorate wind and temperature stresses and both organic and inorganic fertilizers have been applied to address soil fertility constraints. Other practices including terracing, contour planting of trees, and contour strip cropping have been developed to attempt to ameliorate the problems of soil erosion and moisture loss inherent in the cultivation of steep slopes.

Farmers in upland areas of the South are likely to be even more constrained by the environment given the lack of infrastructure development in these areas and their general lack of capital to significantly modify their local environment. Although modification of the environment by small upland farmers is difficult, there are a number of examples of specific situations in the Philippines where farmers have invested resources in order to modify the crop cultivation environment. The most vivid examples of this are the elaborate rice terraces of Northern Luzon. Other examples include the development of indigenous irrigation systems primarily for lowland rice cultivation (Conelly, 1992), the use of contour hedgerows and strip cropping on hillsides for erosion control (Capistrano et al., 1990) and systematic use of green manures and animal manures for soil fertility improvement (Capistrano et al., 1990).

Land availability and characteristics

Land availability and the quality of this land also have a significant impact on household decision making. Land variables most often operate as a constraint on management activities, often in conjunction with the environment. The total amount of land available to the household provides an upper limit to the amount of crops that they can cultivate, animals they can raise and other land-based activities that they can conduct. In the case of tenancy, the household may have limited influence on management decisions such as crop choice.

The interaction between land availability, land characteristics and the environment is also extremely important, especially for households with limited resources. For example, lowland areas may be only suitable for rice cultivation during the rainy season due to a very high water table. Soil characteristics, including both nutrient status and physical properties will also impact management decisions.

Labor availability and returns to labor

Population pressure has long been held to be one of the primary, non-environmental factors that affects household management decisions and changes in agricultural management strategies in general. The major proponent of the important role of population is the anthropologist Ester Boserup (1965). Writing in response to the widely held Malthusian and neo-Malthusian premises that population would soon outstrip food supplies in many parts of the world and eventually for the entire world, she presents a strongly supported thesis that increases in population density have instead been a primary driving force for many of the ongoing changes in agricultural management activities.

Family structure is also believed to have a role in agricultural decision making and management strategy. This thesis is attributed first to the Russian economist, Chayanov (1966), who suggested that family structure, specifically the family size and the ratio of economically productive family members to non-economically productive members (children and elderly), could be used to explain agricultural decision making strategies. His theory suggests that family farm resources are allocated in such a way as to produce the highest returns to labor and that families with larger person to land ratios will accept lower returns to labor.

Peggy Barlett tested these hypotheses along with several others during research conducted in Costa Rica (Barlett, 1982) and found that, in general, the decision to plant tobacco, a highly labor intensive crop, was correlated with household size. In addition, she found that a calculation of returns to labor for various enterprises (as suggested by Chayanov) provided greater explanatory power regarding farmer decisions than did conventional economic analysis.

Risk

Agricultural activities are inherently risky. The outcomes of management practices are uncertain due to the unpredictability of basic factors that influence production and profit such as rainfall and prices. As a consequence, perceptions and attitudes toward risk have been proposed as determinants of farmer decision making in many circumstances (Roumasset, 1979).

Researchers have proposed four general farmer responses to risk. The first is diversification. It has been argued that one of the major driving forces behind the large amount of diversity found on many, particularly small, subsistence-level farms is because diversity minimizes risk. If one crop or activity fails, others are there to pick up the slack (Roumasset, 1979).

The second response to risk has been labeled the "safety-first" strategy. This strategy presupposes that the manager will make the management decisions that are the most likely to insure an adequate supply of food for the household. Once that criteria is taken care of, managers are then more likely to invest any remaining resources (land, labor) into more risky activities (Roumasset, 1979).

The third general response to risk supposes that managers will risk a new management strategy if they perceive the potential benefits to be much higher than the potential benefits from other, less risky, strategies. The amount higher that they need to be is usually called the risk premium.

The fourth general response to risk is that managers seek to develop mechanisms that reduce the uncertainty associated with agricultural production and thereby reduced the perceived risk level. One classic example of this is the development of irrigation systems. The availability of irrigation serves to remove a large portion of the risk associated with insufficient rainfall.

Information availability

There is a generally held belief that the availability of information is an important influence on farmer decision making. First, the availability of information can expand the range of options available to a farmer. Although there is considerable local innovation in cropping and land management strategies, most changes have been facilitated by information about their potential utility that came from somewhere outside the system. Information availability can also influence the level of risk and uncertainty and thereby affect management decision making. For example, the availability and reliability of price forecasts for major crops is likely to strongly influence farmer crop choices.

Participation in the cash economy

Participation in the cash economy is also believed to be a potentially major force that is influencing agricultural decision making. Once households are no longer producing solely or sometimes even primarily for subsistence, their management strategies are likely to change. Another aspect of participation in the cash economy is the possible accumulation of debt. Households that have accumulated debt from past years may find their management options constrained since they must produce for cash to pay the debt before other household needs and goals.

Modeling household decision making

The previous section has provided a general overview of the major types of factors that are believed to influence agricultural management decision making. Given the general interest in the area of land management, particularly in agriculture, it comes as no surprise that a wide number of models have been proposed to predict and explain household decision making. Anderson (1979) provided an extensive typology and description of many of these models. He also suggested a decision-making procedure for choosing the appropriate modeling method based on the goals and objectives of one's analysis.

The first model selection criteria suggested by Anderson (Figure 2.2) is the purpose of the model. Specifically, is the model intended to be normative (a guide for future actions) or is the model intended to be predictive? In this conceptualization, the class of models often called decision support systems (e.g. DSSAT, AGFADOPT) are included in the group of normative models because they are intended to influence future decision making by providing managers with additional information.

In this study, the focus is on the description of existing management decision making strategies. This leads to the next model selection question posed by Anderson

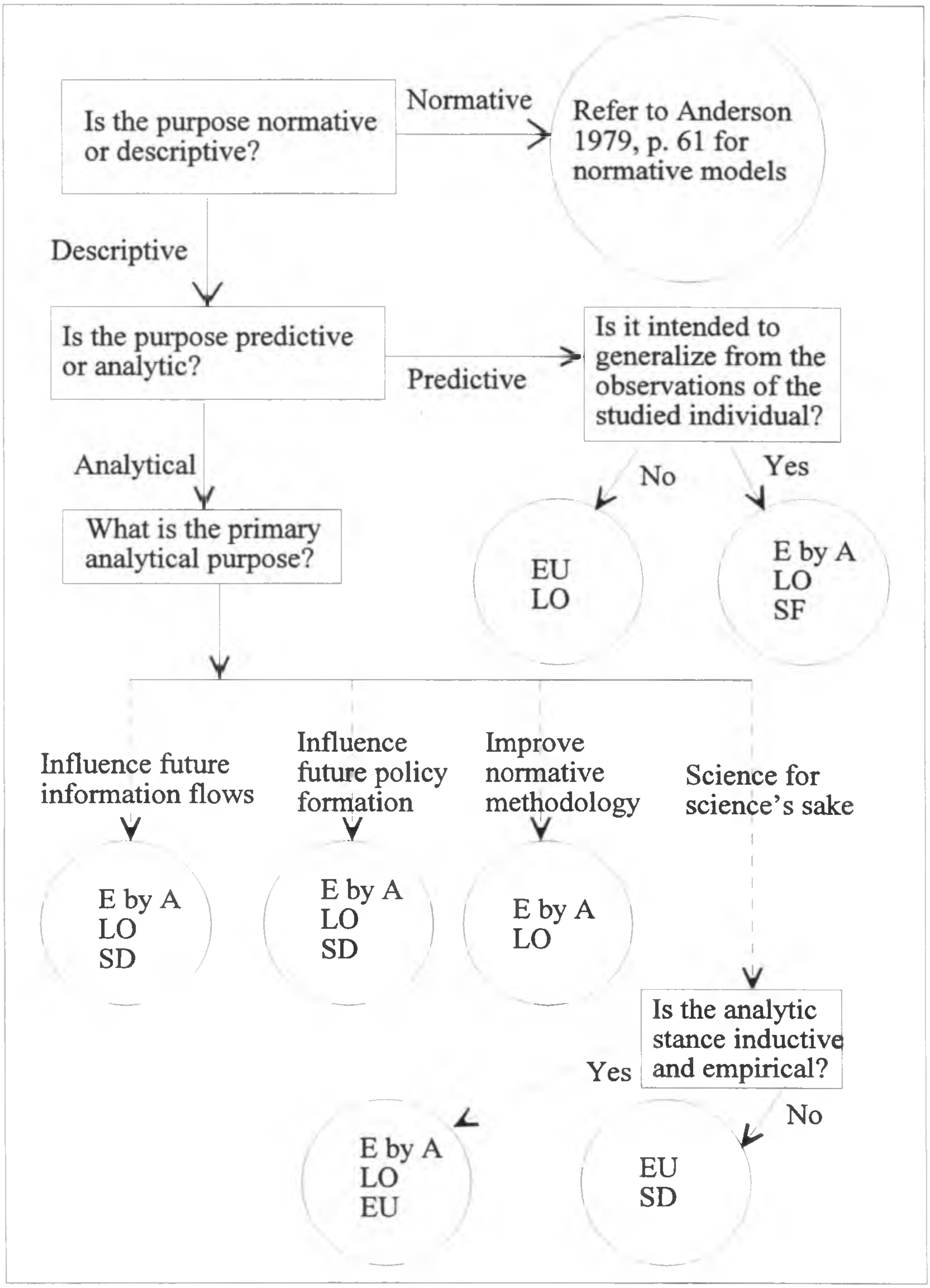


Figure 2.2. Selection of an appropriate decision making model (adapted from Anderson 1979). Model types shown are as follows: Elimination by aspects (E by A), Lexicographic ordering (LO), Expected utility (EU), Stochastic dominance (SD).

(Figure 2.2): "Is the purpose predictive rather than analytical?". As stated in the introduction, this study has both an analytical goal of developing a better understanding of the factors that drive household decision making and a predictive goal of being able to predict household decision making in other similar situations to the study context. Anderson indicates that for a predictive model that intends to generalize from observations of individuals, the preferred strategies are elimination by aspects, lexicographic ordering, and safety-first / safety fixed methods (Figure 2.2).

For analytical models, Anderson identifies four potential purposes: influence future information flows, influence future policy formation, improve normative methodology and science for science's sake. This study is designed to address all four of these purposes. Anderson further divides the fourth category, science for science's sake into two sub-categories based on whether or not the study is inductive and empirical. This study is both inductive and empirical. The only types of models that can meet all of these goals are elimination by aspects and lexicographic ordering (Figure 2.2).

Lexicographic ordering

Unlike other common modeling strategies, particularly those from economics, that rely on often complicated mathematical functions to represent the decision making process, elimination by aspects and lexicographic ordering both use simpler logic. In lexicographic ordering, different alternatives are compared on a prioritized set of criteria.

The most important criterion is considered first followed by as many other criteria as are believed to be necessary. These attributes are considered individually in order of importance. The preferred alternative, which represents be the decision maker's most likely course of action, is the alternative that is better than others on the most important criteria and no worse than others on any other criteria considered. In the case of multiple alternatives, this procedure results in the elimination of all less-preferred alternatives on each of a series of criteria until only one alternative remains (Anderson, 1979).

Elimination by aspects

Elimination by aspects, based on a decision making theory originally proposed by psychologist Amos Tversky (1972), results in a similar process of progressive elimination of alternatives but though a somewhat different process. Tversky proposed that decision makers identify various alternatives or course of actions. These alternatives are then treated as sets of discrete aspects or characteristics. Once alternatives have been identified, decision makers go through a two stage decision making process. In the first stage, which may take place sub-consciously (or pre-attentively) (Tversky, 1972; Gladwin and Murtaugh, 1980), they eliminate all alternatives containing one or more undesirable aspects. In the second stage of the process, a choice is made between the remaining alternatives through the elimination of irrelevant aspects, ordering the alternatives on the most important aspect and passing the ordered alternatives through a series of constraints.

One of the most successful applications of Tversky's theories to specific decision making situations has been the development of decision tree models. Gladwin (1989) cited several examples of the situations where decision tree models accurately represented and predicted local decision making. These included: farmers' choice of crops in Guatemala, farmers' decisions on fertilizer type in Alabama and Guatemala, marketing decisions of fish sellers in Ghana and adoption decisions of farmers in Mexico. A similar approach was used by the author (Robotham, 1995) to model upland farmer adoption of two agroforestry technologies. In contrast to the above examples, the agroforestry model was based on information collected from the literature, not from one specific situation. However, it still retained a relatively high level of accuracy (83% for tree orchards, 68% for hedgerows) although lower than the 85-95% accuracy of the models cited by Gladwin (1989).

Gladwin (1989) also suggested that decision tree models have considerable potential usefulness in agricultural development activities. They can be used to pinpoint the main constraints or factors limiting farmers' choices and be used as the basis for policy recommendations. In addition, they can help answer questions like: "Why did farmers not adopt a new technology?" or "Under what circumstances will farmers be more likely to switch land from annual crop production to the production of cash crops or perennials?" or "Under what circumstances will farmers be more likely to use erosion control practices in upland fields?. Answers to these and similar questions can help development planners and policy makers to better structure projects and policies to encourage the use of more sustainable management systems.

Given the objectives of the study, both lexicographic ordering and elimination by aspects are potentially useful methodologies. I chose to use elimination by aspects in the form of decision tree models for on the following reasons: 1. Decision trees provide a clear and simple representation of the important factors that influence decision making. As such, they can be used as aids to describe household decision making, to identify important constraints to specific decision alternatives, and to identify potentially productive intervention points for development efforts and policy changes; 2. Decision tree models have been successfully used in the context of household agricultural and resource management decisions (Gladwin, 1976 and 1980); and 3. I have previous experience with the successful application of the methodology (Robotham, 1995).

Conclusion

This chapter has provided an overview of the relevant literature underpinning the development of this study and the analysis of study data. Given the explanations and descriptions provided in this chapter, I am now able to formally restate the research problem and study objectives outlined in the introduction.

Research problem

The situation in the Philippine uplands provides a vivid example of household livelihood systems that are facing severe, and often increasing problems. Previous development efforts aimed at increasing system sustainability have generally been unsuccessful. Research results from the Philippines and from other countries indicate that existing, sustainable local management system may potentially provide useful prototypes for future development efforts. However, the information available on Philippine upland management systems, particularly those used by non-indigenous upland dwellers, is very limited. Therefore, this study uses a systematic approach to identify, describe and analyze the sustainability of Philippine upland household livelihood systems and to model the household decision making process.

Study objectives

In order to address the research problem, I have developed three study objectives:

1. To describe the major types of household livelihood systems in three selected upland communities.
2. To evaluate the sustainability of these household livelihood systems using the agroecosystem analysis properties and procedures.
3. To model some of the major household decision making strategies using decision trees.

Through combining the results from these first three objectives, I will be able to address an additional goal of the study: to identify local management systems and decision making strategies that can serve as a basis to help both outsiders and insiders in the development of more sustainable management systems for the uplands of the Philippines and other upland areas throughout the humid tropics.

Chapter 3
Study framework and methodology

This chapter discusses the framework and methodologies that I used in order to address the study objectives posed in the previous chapters. The chapter begins with a description of the overall structure of the study, the advantages and disadvantages of the modified case study framework and the choice of the households embedded in communities as the primary level of analysis. This is followed by discussion of the duration of the study. The third section of the chapter provides descriptions of the processes used to identify the study communities and to identify example households within these communities. The chapter concludes with a discussion of several data related issues: the data needs for the study, the data collection strategies used, an inventory of the data collected and a discussion of the data analysis procedures including specific working definitions of the measures used to evaluate the study variables.

Study framework

There are a number of potential frameworks that could have been used to structure this study. However, I chose to frame the study as a multiple, embedded case study of selected example households in three upland communities. This section begins with some general background on the case study approach and its strengths and weaknesses. This is followed by a justification for the choice of the case study approach in the context of this study and with a justification of the choice of households embedded in communities as the primary unit of analysis.

Overview of case studies

Yin (1984, p. 23) defined a case study as: "an empirical inquiry that investigates a contemporary phenomenon within its real-life context especially when the boundaries between the phenomenon and context are not clearly evident." He also listed three additional characteristics of case study inquiry: case studies deal with the situation where there are more variables than data points, they rely on multiple sources of both qualitative and quantitative data collected through a variety of different methodologies, and they benefit from the prior development of theoretical propositions to guide data collection.

Other important issues for case study design include the choice of the unit of analysis, and the choice between types of case studies (single vs multiple, holistic vs embedded). The choice of unit of analysis determines the type of data collected as does the type of case study. Yin (1984) suggested that multiple case studies are one way to increase the external validity of the methodology; however, he notes that, to increase external validity, the individual cases need to be chosen to reflect a replication logic similar to that of experiments, not a sampling logic. An additional choice for the researcher is between an embedded and a holistic design. An embedded design studies smaller units as individual cases within a larger case whereas a holistic design concentrates on the global nature of an organization or phenomenon.

In addition, as with other research approaches, case study research must address validity issues. Yin (1984) identifies four components that address specific aspects of overall study validity: construct validity, internal validity, external validity and reliability. Construct validity is defined as the extent to which the operational measures used in the study actually measure the concepts of interest. Internal validity is defined as the extent to which the study is able to establish a causal relationship. External validity is defined as the extent to which the conclusions of the study can be generalized to other situations. Reliability is defined as the ability of the study to demonstrate that its procedures could be repeated to yield similar results (Yin, 1984).

Because case studies generally cannot use standard experiments and statistical procedures to establish validity, Yin (1984) developed a list of techniques to help insure that case studies are valid. To address construct validity, he proposed that case studies use multiple sources of evidence and establish chains of evidence. He also suggested that key informants review the investigators initial conclusions. To address internal validity, he suggested pattern matching, explanation building, and time-series analysis. To address external validity, he suggested using replication logic in multiple case studies. Lastly, he suggested the use of a case study protocol and the development of a case study database to address questions of reliability.

Reasons for choosing the case study approach

A multiple, embedded case study design was very appropriate for this study for several reasons. First of all, the case study approach is best applied to situations where the research questions are "how" and "why" questions, control over behavioral events is not possible and the focus is on contemporary events (Yin, 1984). This research had all of these characteristics: 1) The analysis was focused on "how" and "why" issues; 2) Even those issues that are not "how" and "why" issues require extensive information (more variables than data points) 3) this research dealt with actual human systems that were not ethically or practically subject to control; and 4) the research was firmly focused on contemporary phenomena. Secondly, the case study framework provided an opportunity to incorporate a variety of useful methodologies and techniques ranging from ethnographic interviewing to formal surveys. Third, case studies had been used effectively in previous research in the small farm sector (Doorman, 1990). And fourth, using a case study framework with multiple communities and multiple households within these communities seemed to be a potentially useful way to collect appropriate amounts and types of data within the time, resource and personal constraints of the research.

The choice of multiple cases instead of a single case was based on two, somewhat conflicting, factors. One was the exploratory nature of the study. Since little is known about sustainability in upland systems, a broad range of sites was likely to provide a wider range of information. The second reason was related to the issue of external validity and the idea of replication logic. The similarities and differences between multiple sites provided some additional ground from which to generalize to a wider area.

Level of analysis

As discussed in the previous chapter, the primary level of analysis used in this study was the household. However, the study did not focus exclusively on the household level. Since I believed that community level factors might play a significant role in the development and maintenance of household sustainable livelihood systems, I chose to conduct an household-based study imbedded in a set of communities.

Other issues

Several other issues influenced the choice of study framework, study location and data collection procedures. The major issues involved were time constraints, resource (financial) constraints and family issues.

Time

The time required was an important issue in research design. The duration of this study was limited to no more than one year due to funding constraints. However, one year provided sufficient time to address the study questions. Most importantly, I was able to collect data throughout the calendar year. Researchers (Chambers et al., 1984; Gill, 1991) have observed that the livelihood situations of small-scale agriculturalists (such as the upland dwellers in this study) can change greatly depending on the time of year when data is collected.

The limited amount of time also influenced the number and location of the study communities. Based on my initial site selection and data collection efforts, I decided to limit my activities to three communities. I wanted to conduct repeated interviews with informants spaced throughout the year in order to increase the study validity (multiple types of information) and to address the potential seasonal considerations discussed above.

Resource constraints

In addition to the time constraint, the study was constrained by the availability of resources, specifically financial resources. Although I received a generous Fulbright-Hayes Doctoral Dissertation Research Abroad Grant from the United States Department of Education and the Philippine-American Education Foundation, this did not provide me with extensive funding for the research over and above basic living expenses. This had an impact the selection of study communities and the number of communities. Specifically, travel to and from research sites was constrained to available public transportation.

Family issues

My family situation also had an impact on the study design. Because I am married and had a small child, I did not feel that I could spend the entire duration of the study living in one or more small upland communities. As a consequence, my wife and son stayed with her family in the Manila area and I traveled regularly between Manila and the study sites.

Selection of study communities

Another fundamental issue that must be addressed in case study research is site selection. According to Marshall and Rossman (1995) the attributes of an ideal study site include: entry is possible, there a high probability of a rich mix of the people, processes, structures and phenomena of interest are present, the research is likely to be able to build trusting relations with study participants, and data quality and credibility of the study can be reasonably assured. In this section, I will present the general community selection criteria that I employed in the study. This will be followed by a description of the process I actually followed to identify the three specific study communities. A more detailed description of the three study communities is provided in Chapter 4.

Community selection criteria

Based on the goals and objectives of the study, the attributes of an ideal study site discussed above and in consideration of the other relevant issues, I developed the following minimum criteria for site selection:

1. Sites are in upland areas.

2. A large majority of residents are immigrants (or descendants) from lowland cultural groups.

3. Sites have moderate-long history of settlement. I would prefer a settlement history as far back as the 1950's. The initial settlers in all study areas must have arrived at least 20-25 years ago (1970-75). Most migrant areas have a mix of migrants with the oldest residents having arrived soon after WW2 and some residents having arrived as recently as 5-10 years ago.

4. Sites are characterized by small agricultural producers/resource managers. I am not interested in areas predominantly characterized by intensive irrigated rice cultivation (although this may be a component of some systems) or by large plantations or ranches.

5. Some form of local organization or local branch of a government organization is present (e. g. ISF project, Samahang Nayon (farmers association), NGO activities)
   5a. Staff of the organization are amenable to study objectives and willing to assist with initial project activities

6. A relatively contiguous study area containing approximately 50-100 families is either already defined by the organization or program in #5 or can be readily defined through cooperation with local residents and officials.

7. Sites are geographically separated in order that the study can capture a wider range of physical and socio-economic conditions.

8. Sites are located in a primarily Tagalog speaking area although Tagalog need not be the first language of all residents.

9. Sites are located close enough to Manila to make regular trips possible and are accessible using public transportation and a moderate amount of walking (less than four hours).

Actual community selection process

Although I had developed what I felt was a reasonable set of community selection criteria, the actual identification of study communities turned out to be a much more complicated process. Selection of the first study community was the easiest of the three. I wanted to return to the area where I had served as a Peace Corps volunteer in the late 1980's and this proved to be possible. Due to my previous residence in the area, I was able to renew contacts with both farmers and Department of Environment and Natural Resources (DENR) staff and organize my work in *sitios*

Imbarasan and Himamara, *barangay* Mapaya, in the municipality of San Jose in Occidental Mindoro province.

Philippine community names

A slight digression is required at this point to explain the system of community names employed in the Philippines which is somewhat different from the system used in the United States. The Philippines is divided into provinces which are in turn divided into municipalities. The municipalities carry the name of their major population center; however, they are closer to concept of a county in the mainland United States (having both rural and urban areas) than a city. These municipalities in turn are divided into *barangay* largely on the basis of population. As a consequence the physical size of *barangay* can vary greatly although the populations are relatively similar. Because the dispersed nature of populations in rural areas results in large land areas being contained in one *barangay*, these larger barangay are divided into *sitios*. *Sitios* are smaller, contiguous areas usually inhabited by approximately 50-100 families. In very rural areas they can include several hundred hectares.

Selection of the second study community

I had originally planned to select a predominately *Mangyan* (the native inhabitants of Mindoro) community located a few kilometers from Imbarasan and Himamara as a second study site. However, I was advised by the DENR personnel working in the site and by some of the residents that my work in that site might be difficult due to the recurring presence of members of the New People's Army (NPA), the Maoist revolutionary movement in the Philippines. Identification of an alternative site near San Jose also proved difficult due to the lack of support from the overextended DENR field staff.

As a consequence, and in pursuit of a different physical and socio-economic environment, I consulted colleagues at the South-east Asian Ministers of Education Organization Regional Center for Graduate Study and Research in Agriculture (SEAMEO-SEARCA) and they suggested that I conduct part of my research in *sitio* Halang, *barangay* Bayugo, in the municipality of Jalajala in Rizal Province. SEARCA was involved in some ongoing research there and there appeared to be opportunities for collaboration and data exchange. In addition, a field technician employed by SEARCA was assigned to the area and could help me with community entry. This arrangement turned out well and Halang became the second study community.

Selection of the third study community

Selection of the third study community turned out to be much more difficult than the first two. Based on the criteria given above, I wanted to locate a community in a different physical and socio-economic environment that was still in a Tagalog speaking area and reasonably accessible to Manila. I initially identified a site near the University of the Philippines at Los Baños (UPLB) in Quezon province; however, further investigation revealed that this site had a climate very similar to Imbarasan and Himamara. In addition, there was some question about the community entry possibilities in the area since there was not a resident project or government technician. There was also some concern about the potential presence of the NPA in the area. Through an extremely convoluted series of connections, I was able to identify another potential site in another part of Quezon province, on the Pacific coast of Luzon in the municipality of Infanta. A very active local non-government organization, the Infanta Integrated Cooperative Development Alternatives Incorporated (ICDAI), was interested in possible cooperative work.

I traveled to the area in the company of the NGO director and his assistant and tentatively identified an area composed of three *sitios*, KM 12, Kakawayan and KM 9 in the *barangay* of Magsaysay, Infanta municipality as the third study site. Since this area is in the upper (uphill) part of *barangay* Magsaysay, I will refer to it a Upper Magsaysay instead of repeatedly using all three *sitio* names. Unfortunately, after my first visit to the site, it became apparent that some issues in the area (specifically the residents' dependence on illegal timber harvest for much of their income) could potentially make community entry very difficult. In addition, it had taken considerable time to identify the site and at that point I felt that I did not have sufficient time to devote to three sites. So, the I shelved the Upper Magsaysay site and decided to focus exclusively on the Imbarasan / Himama and Halang sites.

However, other circumstances led me to reconsider this decision. Near the middle of the year, NPA soldiers returned to Imbarasan / Himamara as part of renewed effort by the NPA to assert its influence in upland communities in Mindoro. I discussed the situation with my friends in the area and they advised me that continued research there was not a good idea since the NPA has a long standing anti-US policy and had been involved in the kidnaping of a Japanese researcher in another part of Mindoro in 1995. As a consequence, my data collection activities in Imbarasan / Himamara came to an abrupt halt. At this point, I decided that, in order to meet the study objectives, I needed data from an additional site. At that time, I contacted ICDAI again and was able to conduct additional data collection activities in Upper Magsaysay.

Selection of example household livelihood systems

After the study communities had been selected, the next task of the study was to identify example household livelihood systems. These served as the basic units of analysis for the remainder of this study. In this study, I have decided to use the term "example households" since these households were chosen to represent examples of the variety of management systems and family situations found in each community. In this section, I will first discuss the potential criteria for identifying example households that have been proposed and used by other researchers. I will then discuss the specific procedure to be used in this analysis.

Household grouping procedures from previous studies

Researchers have suggested several criteria for the identification of groups of households and of example households within these groups. In his discussion of farmer systems research from a theoretical perspective, Collinson (1983) suggested the use of three general factors: climate and soils, tribal or social background, and man/land ratio in order to first group households. The Benchmark Soils Project (Cagauan et al., 1983; Uehara,1984) based at the University of Hawaii was based on the premise that soil properties were the appropriate factor to use to identify those households most likely to benefit from the transfer of specific agrotechnologies. The project also recognized the importance of climate factors, topography and farm management practices and attempted to incorporated these into modeling activities. Although the project did recognize the potential impact of socio-economic and policy factors, these were generally not considered in project activities. Jolly (1988) was able to identify four groups of households in the Ziguinchor Region of Senegal using a cluster analysis algorithm. The following variables proved to be important in discriminating between groups: total non-agricultural revenue per active farm laborer, amount of fertilizer used, the use or non-use of herbicides, the use or non-use of animal traction for plowing and the total cultivated area per farm laborer. Using this procedure, he was able to identify the characteristics that appeared to differentiate between households that were self-sufficient in food production and those that were not.

Although all three of the above citations suggest how to group farmers, only Collinson provided suggestions as to how model or representative households can be identified within these larger categories. He suggested selecting for households with minimum variation from the most common values of the following characteristics: cropping patters, labor supply and use, labor profile, scale, assets and output

(Collinson, 1983). This focus on the "average" household has been criticized since it may obscure significant variation between households within the same household grouping (Ravnborg, 1992). For example, even if the average land size is two hectares, there may be very few "average" households with exactly two hectares of land. Instead there may be a large group of households with very small holdings and a small number of households with very large holdings. To avoid this problem, Ravnborg (1992) suggested that researchers be explicit about their grouping variables and be prepared to change them or add additional groupings in the course of their analysis if they become aware of this type of situation.

Example household identification procedure used in this study

Since the focus of this analysis was the household, I needed to identify a set of example household that will serve as the basis for the household level case studies. Based on the ideas from the literature, the household-level data I collected over the course of the research, and my own perceptions, I was able to identify example household livelihood systems in each of the three study communities. In order to do this, I used the following criteria:

1. Land type (s) available to the household (lowland, upland, both, presence/absence of irrigation)
2. Major household enterprises (e.g. annual crop mix, perennials, livestock)
3. Family size and household stage in the life cycle
4. Land size

5. Availability of data on the household

I applied these criteria to the formal survey data from the three communities, and, using my own best judgement, I was able to identify six example households in Imbarasan / Himamara, seven in Halang, and four in Upper Magsaysay. These 17 households represent different groups of households. I also identified three special cases that illustrate rare household livelihood systems. Although these systems were uncommon, they represent alternative management strategies that may be more sustainable than other, more common systems. Two of the special cases were located in Imbarasan / Himamara. The third was in Halang. Brief descriptions of the 20 example households can be found in Chapter 4; while detailed household descriptions can be found in Appendix 2.

All of these example households were based on one actual household; however, they were not intended to be complete and perfectly accurate descriptions of specific households. There were two reasons for this: privacy issues and gaps in the data. First of all, although I obtained permission from interviewees to use information they provided for my dissertation, I was personally uncomfortable about providing detailed descriptions of specific households without their express permission. Given time and resource constraints and the difficulties associated with explaining the study to community residents, getting explicit approval over household descriptions would have been very difficult. Secondly, in addition to the difficulties associated with privacy, providing complete descriptions of all example household livelihood systems would have required that I return to the communities, collect additional data, and validate these descriptions with the households. Again, this would have been very difficult due to time and monetary constraints. In order to address these two issues, I removed names and tried to remove other obvious distinguishing household characteristics that did not directly add to the livelihood system descriptions. With regard to missing data, I made what I believed to be reasonable assumptions for values of missing data generally based on mean values from other, similar households. The assumptions made in each specific case are stated in Appendix 2 in the context of the detailed example household descriptions.

I had originally planned to use the households of my key informants as the basis for all of the example households. This proved to be impossible. As noted later in this chapter, my key informants were generally the more progressive and innovative land managers in the three communities. This was partly by design and partly because those people were more willing to take the time to talk to me at some length about their management systems. When I went back, looked at the data, and applied the household grouping criteria, I realized that if I used only this group of key informant households, I would miss a significant amount of the variation within the communities. As a consequence, I developed additional example household descriptions based primarily on survey data. Key informant households (supplemented with information from the formal surveys) still made up 13 of the 20 example households (7 of 8 in Imbarasan / Himamara, 5 of 8 in Halang, 1 of 4 in Upper Magsaysay).

Issues related to the study data

A study is not a study without the collection and analysis of relevant data on which analysis is conducted and from which conclusions are derived and inferred. The remainder of this chapter focuses on the data used in this study. It is divided into three sections: identification of data needs, data collection and data analysis.

Identification of data needs

The first important data related activity in any study is to identify the data needs, that is, the potential types of data that will be necessary to meet the study objectives. This section summarizes the data needs that I identified related to the three objectives of this study.

Objective number one: livelihood system description

The first objective of this study was to describe the major types of household livelihood systems in the three selected upland communities. A large amount of information could be used to describe the major types of household livelihood systems as well as the communities in which they are located. Description of the community could include a variety of factors including: the bio-physical environment (e.g location, area, elevation, topography and rainfall), demographics (e.g. population), socio-cultural factors (e.g government structure, ethnic background), history (e.g. settlement patterns), and economics (e.g. incomes, employment opportunities).

At the household level, potentially important descriptive data included information on land holdings (e.g. land type, size and tenure status), agricultural practices (crops, management practices, yields), animal husbandry (numbers, types and uses), perennial species, both from household land holdings and from common lands (numbers, types and uses), family size and structure, major income sources, major expenses and use of credit.

Objective number two: sustainability assessment

The second study objective was to evaluate the sustainability of these community and household livelihood systems using the agroecosystem analysis properties and procedures. As discussed in the previous chapter, I chose to use the agroecosystem properties as the variables in this study to allow me to address the more general concept of sustainability. These nine properties (productivity, stability, maintenance, resilience, equitability, autonomy, solidarity, diversity and adaptability) were defined in the previous chapter. In this section I provide a list of the types of measures typically used to assess the values of these variables. All nine variables could potentially be addressed at both the household and community levels.

Productivity

Potential indicators of productivity at both the household and community levels included: 1) Total annual income, 2) Total annual yield of harvested food energy (MJ) per hectare, 3) Total annual harvested food energy per capita (adult equivalent), 4) Relative annual crop yield per hectare as compared with local or national averages, and 5) Relative annual crop yield per hectare as compared to theoretically expected yield derived from some other source such as a crop model.

Stability

An ideal assessment of stability would incorporate time series data; however, since this research took place over only one year and since reliable data from previous years are unavailable, I had to identify other potential types of data. These included: information from local residents about conditions in the past and variability over time, existing data that might be available to validate information provided by residents, my own knowledge, and information from the literature on the stability of similar types of systems and system components.

Maintenance

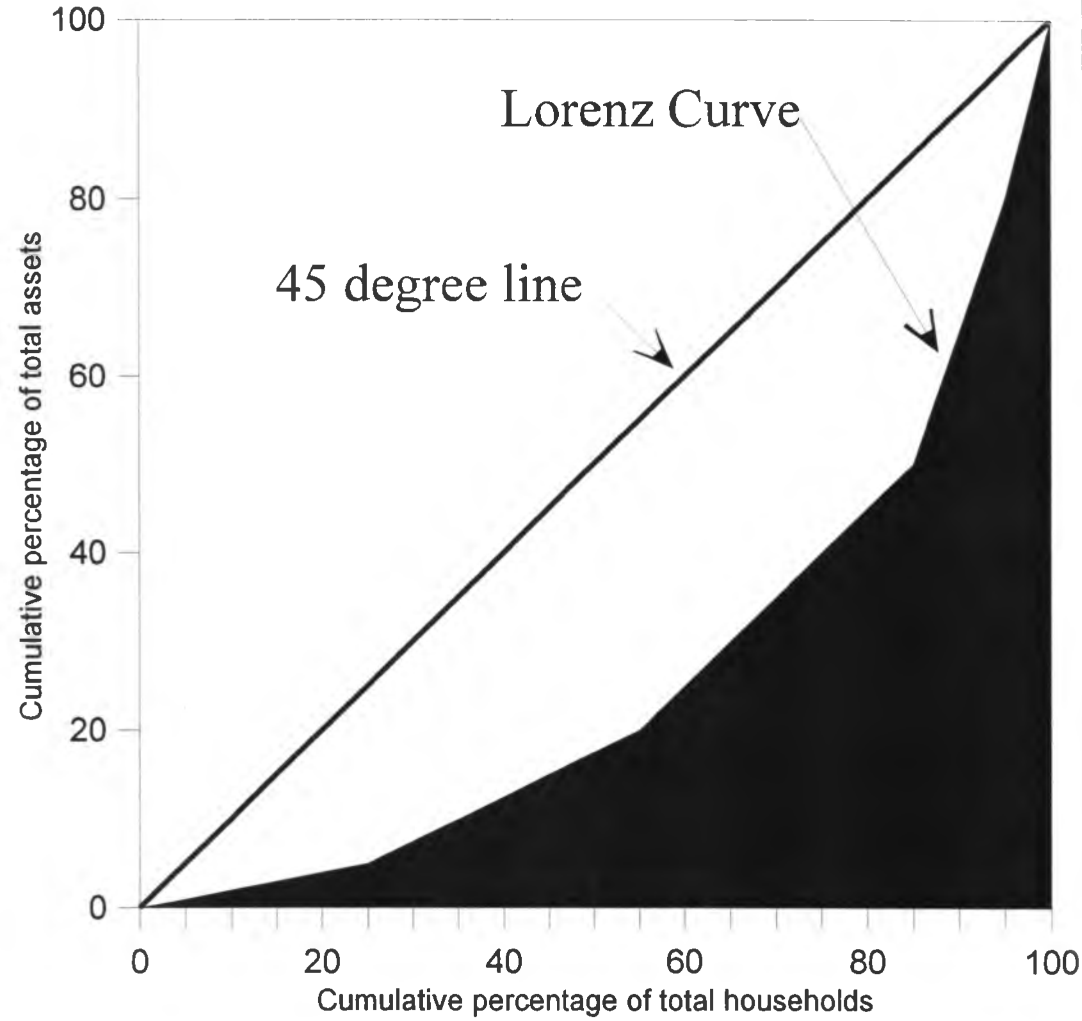
Like stability, maintenance was more difficult to assess without time series data. As a consequence, I identified other potential indicator variables. One potential data source was resident recall of the past situation and comparison to the present. Several potential indicators of increasing stress (lower maintenance) in the system including decreasing yields and increasing need for fertilizer application were also identified. Other measures that might be used to indicate the existence or at least potential for increasing stress are decreasing fallow periods without corresponding fallow enrichment strategies and evidence of soil erosion. These could be elicited from residents, observed by the researcher or deduced from other associated data.

Resilience

As in the case of maintenance and stability, resilience was likely to be difficult to assess without time series data. As a consequence, other data sources were necessary. Possibilities at the community level included: resident recall of past events and trends and the community population trend over time. A skewed age distribution in the community (more older people and children but few young adults) might also provide an indicator of system resilience. At the household level, all of the households that I interacted with are by definition resilient or they would not still be in their community. However, discussions with these households could provide some insights from residents regarding why they were still there but others were gone.

Equitability

The UNDP (1990) suggested three variables on which to base measures of equitability at the community level: total household income, per capita income and land holding size. One common way to measure the equitability of the distribution of these variables was to use the Gini ratio. The Gini ratio is defined as the ratio of the area between the Lorenz curve and the 45 degree line of perfect equitability and the total area below the line of perfect equitability (Figure 3.1). Therefore, the Gini ratio theoretically ranges from 0 (perfect equality) and 1 (perfect inequality). A Lorenz curve is drawn by plotting the cumulative percent of the asset of interest (income, land, etc.) vs the cumulative percent of the population (Gillis et al. 1987, p. 75). Another commonly used indicator for income-based variables is the ratio between the average



The Gini ratio, G is calculated as follows:
G = (Area between the Lorenz curve and the 45 degree line / Total area below the 45 degree line)

G = 0 if there is perfect equality
G= 1 if there is perfect inequality

This figure has a Gini ratio value : G = 0.48

Figure 3.1. Example of the calculation of the Gini ratio

of the richest 20% of the population and the average of the poorest 20% (UNDP, 1990).

Autonomy

At the household level, one potential measure of autonomy was the recycling ratio, the ratio between the amount of household production that cycles within the household and the total household production. A high recycling ratio would indicatea high level of autonomy. However, highly accurate calculation of the recycling ratio required very detailed data. Other, less data intensive indicators of autonomy considered included: reported use of external inputs, whether or not the household was self-sufficient in rice, how dependent the household was on off-farm income, and the number and amount of sold products and cash expenses.

Autonomy at the community level could be assessed through a comparison of the sources of various community inputs and the ultimate sale destination of community products. This again would require large amounts of data. However, it may be possible to develop an assessment of community autonomy based on general knowledge about the relations between the communities and the larger natural and social-economic environment.

Solidarity

At the community level, one potential indicator of solidarity considered were residents reports of community cohesion. Other evidence of community solidarity could comes from the existence of community groups and labor sharing arrangements.

The existence of common points of origin, linguistic background and kinship ties might also indicate increased community solidarity. At the household level, potential indicators of solidarity could include family cohesion and family consensus regarding household goals and objectives.

Diversity

There were a number of potential measures and indices available to assess system diversity. However, given the systems in the study communities and the types of data available, I concluded that the simplest measures were likely to be the most useful. Simple potential measures of diversity considered included: number of species used by the household (annuals, trees, animals and/or forest products), number of guilds, and the number of income sources. A guild was defined following Dalsgaard and Oficial (1997). Instead of considering individual species, the guild concept considered groups of similar species with similar attributes or functions (e.g. rice and maize could be combined as the guild "cereal crops" and buffalo and horses could be combined as the guild "work animals"). These same indicators could be applied at the community level using community mean or median values.

Adaptability

As with many of the variables discussed in this section, adaptability was also believed to be difficult to assess. The primary measure of household adaptability that seemed most appropriate for this study was evidence that residents provide of how their management systems had changed in the past. Other proxy indicators of adaptability, such as examples of experimentation, could also be useful. At the community level, adaptability could be assessed as relative level of how quickly most households have adopted beneficial system changes.

Objective number three: modeling household decision making

The third study objective was to model the major household decision making strategies using decision trees, a simple type of decision making model. The development of decision tree models required information on household goals and preferences and on constraints to management options. Possible household goals and preferences included: insuring a stable food supply at the lowest possible level of risk, increasing cash income or preserving the land resource for one's children. Possible constraints to management options included: tenure issues and the availability of land, labor, materials, capital and information. The primary data needed to determine all three of these types of information were descriptions of local decision making processes. Potentially important components of these descriptions included: the potential alternative courses of action considered by the household, the major factors that influenced manager's choices, the major constraints on decisions, and, as much as possible, manager's descriptions of the process that they followed to make the management decision.

Data collection

The next step in this description of the study methodology is to discuss various aspects of data collection. In the previous section, I discussed the data needs. In this section, I identify the potential sources of this data. I also briefly discuss some of the theoretical issues behind the data collection procedures and the strengths and weakness of the procedures. The section concludes with a description of the data collection procedures I employed in this study and an inventory of the available data.

Potential data sources

As described in the previous section, meeting the study objectives: 1) Describing existing household systems, 2) Assessing the sustainability of the three communities and 20 example households and 3) Modeling manager decision making for important management decisions, required multiple sources and types of data. There were two principal reasons for the use of multiple data types and sources. First of all, the study was an exploratory study focused on the household livelihood system. This system involved a large number of components that were influenced by each other and by factors from outside the system. As a consequence, developing a description and understanding of this type of system required collecting multiple types of data from multiple sources. Second, one of the fundamental ways to enhance the construct validity of case study research is to use triangulation, the collection of similar data from a variety of sources (Yin, 1984). Since establishing validity is an important component of any research project, I attempted to triangulate my information as much as possible.

Data collection procedures — advantages and disadvantages

Four different data collection methodologies were used in this research. They were: analysis of existing data, interviews with land managers, personal observation, and soil sampling. In this section, I discuss the advantages and disadvantages of each of the data collection strategies.

Analysis of existing data

Historical records and other existing data can be potentially very useful in this type of study. This type of data includes all previously collected information that is available for use. This can include: weather station records, soil maps, topographic maps, cadastral surveys, agricultural yield records, census data, reports from previous projects, agency progress reports and articles published in the media.

Potential benefits

There are several potential benefits from using existing data. First of all, it saves time (Singleton et al., 1988). Data that has already been collected may not have to be collected again; although its current applicability may need to be verified. Second, some data is difficult or expensive for an individual researcher to collect (Singleton et al., 1988). For example, measuring rainfall requires daily checks of a rain gauge (or hiring someone else to do it) and constructing topographic maps and even accurate land surveys requires special equipment, considerable experience and a large amount of time. Third, historical data may provide a basis from which to detect changes in livelihood systems over time (Singleton et al., 1988). For example, a report from work in the area ten years ago may indicate that no one was cultivating a particular crop; however, your research may show that the crop is now commonly grown. Lastly, existing data can provide the researcher with valuable orientation information that can ease community entry difficulties (Singleton et al., 1988). If the researcher has some idea of some basic community attributes, farming practices or other information, they will be able to better communicate with local residents.

Potential difficulties

There are some potential difficulties with the use of existing data, particularly for marginal upland areas like the study communities in this research. The major difficulties concern inadequacy, the data simply is not available, and the potential for inaccuracy in the original data (Singleton et al., 1988). Both of these problems were likely to exist in this research. First of all, data from marginal areas like the Philippine uplands is often unavailable. Systematic land holding and soil surveys have not been conducted in many areas. Harvest and yield information was seldom collected. Few projects have worked in upland areas and even in areas where projects have operated, project documents have often been lost, if copies were even provided to local officials. Second, even if data is available, it is often incomplete or inconsistent. This is often the case with surveys of land holdings. Surveying in sloping areas is extremely difficult and the government technicians assigned to the task often lack the appropriate tools and experience resulting in unreliable surveys. In another example, weather stations are often located in cities on the coast that may be some distance from upland areas. As a consequence, although the general weather pattern is likely to be correct, they do not provide information about smaller scale weather phenomena. In addition, because of accessibility problems and jurisdictional issues, census data, land use data, and agricultural production data from these areas, if it exists at all, is often incomplete.

Interviews with land managers

Interviews with land managers are one of the most widely used and accepted data collection strategies for accumulating the data required to describe and analyze household livelihood systems and management decision making. It is increasing clear that local residents are knowledgeable about their management systems, the interactions within their system and between it and other systems and existing problems with their system. This is true even if the outsiders are "scientific" experts (Chambers, 1994; Webber and Ison, 1995). The specific interview strategies used can be divided into two general types: unstructured interviews (aka informal interviews) and structured interviews. The extreme form of the structured interview is the questionnaire or formal survey.

<u>Differences between interview strategies</u>

Although several levels of structure are possible in interviews, in this section, I will concentrate a comparison between the two extreme levels of structure, the informal interview (very unstructured) and the formal survey (very structured). In addition to the level of structure, there are two other major differences between the formal survey and the informal interview: 1) the selection of interviewees, and 2) the interaction between the interviewer and the respondent (Singleton et al., 1988).

The first difference between informal interviews and formal surveys is in the level of structure. In a formal survey everyone who is interviewed is asked the same set of questions in the same order. Often these are written on a standard form or questionnaire for ease and consistency of administration. In contrast, in an informal interview, each respondent is not necessarily asked the exact same question or set of questions. In addition, a formal survey only seeks answers to the predetermined set of questions. There is usually little room for the respondent to add additional data or to discuss related topics. In contrast, an informal interview provides much more flexibility on the part of the respondent to expand on particular points and to bring up areas of interest (Marshall and Rossman, 1995).

The second difference between the approaches is in the selection of who to interview. This decision is directly related to the different ways used to increase validity in these two procedures. In a formal survey, which attempts to insure validity through statistical means, it is most common to survey a sample of land managers in a given area. If the area of interest is small enough, all households can be surveyed. If all households can indeed be surveyed, the result is referred to as a census. In most situations, not all households can be surveyed, even if that is the preferred strategy, since people may not be home or may be unwilling to answer questions. In this case, the result is often referred to as a saturation sample, a sample of everyone who would participate in the study. In research conducted with large populations where a census or saturation sample would be impractical or very expensive, the researcher usually attempts to survey a statistically valid sample of the population using one of a variety of accepted sampling procedures (Marshall and Rossman, 1995).

In contrast, an informal interview procedure seeks to assure validity through the collection of in-depth information from a smaller number of respondents. To this end, informal interview procedures often make use of key informants and local experts. A key informant is a local resident who has developed a close relationship with the researcher and proven to be a reliable source of information. A local expert is a local resident who has a significant amount of relevant knowledge in a particular area or areas and is willing and able to share that with the researcher.

Identification of key informants and local experts can be difficult but is an important part of any study that relies on informal interviews. In some cases, local agency staff will serve as the starting point for identification of potential interviewees. However, final identification of key informants is more difficult than the identification of local experts since it is highly dependent on the personal relationship and personal trust between the local informant and the researcher. Identification of local experts may be somewhat easier since they are more likely to be asked to provide specific, often technical, information in an area where their skills are recognized. In either case, it is important to collect information from multiple sources to increase validity.

The third major differences in the two approaches is related to the respective roles and level of control of the process held by the interviewer and the respondent. In a formal survey, the interviewer is in control. The questions are set in advance, and the respondent is asked to provide answers to these specific questions regardless of their personal feelings about whether the questions are meaningful or useful in describing their household livelihood system.

In contrast, in an informal interview, control is shared between the interviewer and respondent. To this end, informal interviews can be thought of as a specific type of conversation. Although it is the interviewer who initiates the conversation and may attempt to keep it flowing in a particular general direction; in good informal interviews, the respondent is free to expand on areas that he/she feels are of particular importance and skim over those of less importance. The respondent is also free to seize the initiative and direct the discussion to additional topics of which the interviewer may not have been aware (Marshall and Rossman, 1995).

Advantages of the formal survey

There are four principal advantages of the formal survey. First, because respondents are asked identical questions, it facilitates comparison between respondents. Second, if a statistically valid sample is used, the researcher can use analysis of the survey results to make reliable inferences about the overall characteristics of the population of interest. Third, since the question format is fixed, the formal survey can be administered by someone who is not intimately involved with the study. The final advantage of a formal survey is related to the third. Since the format is fixed and does not generally allow for elaboration on the part of the respondent, it can be administered relatively quickly. This facilitates the administration of a survey to a large number of respondents (Marshall and Rossman, 1995).

Disadvantages of the formal survey

The primary disadvantage of the formal survey is that it is inflexible. Unless the researcher has a very good understanding of the situation of interest before the survey is developed, there is a significant chance that things that are important to local residents may be left out of the survey. Since statistical generalizability rests on identical questions and a random sample, it is virtually impossible to revise a formal survey once it has started. One way to reduce this problem is to pretest the survey on a population that is similar to the population of interest. However, this does not guarantee that there problems will not occur in the actual survey due to differences between the pre-test and survey population (Marshall and Rossman, 1995).

Advantages of the informal interview

Flexibility is the primary advantage of both unstructured and semi-structured interviews. Unstructured interviews are extremely flexible and allow the person being interviewed to direct the conversation toward topics of personal importance or interest. This can help the researcher to gain valuable information that otherwise might not have been discovered. An additional advantage of informal interviews is that they provide an opportunity for the development of a rapport between the interviewer and respondent. This may result in the collection of more accurate and more detailed information. This is particularly advantageous for subjects that may be perceived as more personal than others such as income, semi-legal or illegal activities (Marshall and Rossman, 1995).

Disadvantages of the informal interview

The principal disadvantages of the informal interview are the risk of bias in the interaction between the interviewer and the interviewee (Marshall and Rossman, 1995) and the lack of the directly comparable, statistically valid comparisons across interviewees that are possible with a formal survey. Since the researcher provides only minimal guidance, different informants may discuss significantly different topics or may frame their responses differently even if they are discussing similar topics. An additional disadvantage of the informal interview is that effective informal interviewing requires an interviewer who is intimately familiar with the details of the research project. Furthermore, conducting effective informal interviews takes a considerable amount of time. As a consequence, informal interviews usually can usually only be conducted with a relatively small number of respondents (Singleton et al., 1988).

Personal observation

Personal observation is the third data collection strategy that may be useful in this study. Personal observation by the researcher can include observations related to land use, productivity, management problems, household wealth and status, general health of the population and a variety of other factors. It is also important to note that, except in very unusual circumstances, ethical personal observation is done openly, not secretly.

Advantages

Personal observation has three primary advantages. First of all, it can be used to validate information collected with other methods such as interviews or historical records. Second, it can be used as a basis for further data collection such as the development of questions or lines of questioning for formal and informal interviews or the identification of areas where soil sampling might be most useful and informative. The third advantage of personal observation is that it may allow the researcher to learn about attributes of a given situation that informants are reluctant to discuss. For example, observing the size and condition of a house and the items inside can give the researcher a general idea of the household's income status without having to specifically ask a potentially delicate question concerning the family's income (Singleton et al., 1988).

Disadvantages

The primary disadvantage of personal observation is that the researcher may make incorrectly interpret his or her observations. Taken by themselves, observations are open to misinterpretation because the observer may have limited knowledge of the exact circumstances surrounding the observation (Singleton et al., 1988). For example, a researcher might observe severe soil erosion in fields and conclude that farmers are not aware of the soil erosion process. However, additional discussions with farmers may reveal that they are well aware that their land is eroding but they have to continue planting the areas because they have no other land available to them.

Soil sampling

Given the lack soils information from Philippine upland areas, another data collection methodology that would appear to have significant potential use in this analysis is soil sampling and testing. Information from soil tests can be used in four general ways: 1) To provide an index of the nutrients available in a given soil, 2) To predict the probability of obtaining a profitable response to lime or fertilizer, 3) To provide a basis for lime or fertilizer recommendations and 4) to evaluate the fertility status of soils in a larger area in order to develop farm or regional level nutrient management programs (Tisdale et al., 1993). In this section, I will focus on the surface soil sampling for soil fertility assessment related primarily to suitability for annual crop production at the field, farm and community levels.

<u>Advantages</u>

The primary advantage to the collection and analysis of soil samples from specific study areas is that this could provide current, location specific, measurements of some of the basic local soil properties that may affect plant growth including texture and nutrient status. There are three principle uses for these analyses. First of all, the researcher may be able to provide local managers with information that will help them to better manage their holdings, thus giving back some information in return for their help with his/her research. Second, based on these samples, the researcher can develop some general ideas about the types and fertility status of the soils in the study area. This may help the researcher better understand local decision making and land management strategies. Third, this soils information can be used as the baseline data in a simulation model that will allow the researcher to estimate the theoretical maximum yield of a given crop in these conditions. This can then be compared with current yields to better understand system constrains and opportunities.

Disadvantages

The primary disadvantage of limited surface soil sampling is that it does not allow the researcher to determine soil nutrient status beyond the limited area sampled (Tisdale et al., 1993). This is particularly true in upland areas that have a varied landscape. As a consequence of this variation, there is often extreme soil heterogeneity in these areas and even on individual land holdings (Wollenberg, 1985). In addition, surface soil sampling is unlikely to detect potential sub-soil factors that may have a significant impact on plant growth such as sub-soil acidity or hardpans that limit root growth.

Data collection procedures used in this study / inventory of available data

In this study, I developed a data collection plan that provided the data required to meet the study objectives in the context of the constraints to the study discussed earlier in this chapter. In this section, I discuss how I used the data collection procedures described above and will inventory the types of data collected using these procedures.

Existing data

In spite of the general lack of available data from upland areas, I was able to collect and make use of a considerable amount of existing data, particularly from the Halang study site. This data can be divided into several types: maps and associated information, weather information, soils information, demographic data and previous research studies.

Maps and associated information

I obtained the specific location and approximate area of each of the three study sites. For each site, I obtained the appropriate 1:50000 topographic sheets from the government mapping office. However, the micro-relief that appeared to play a pivotal role in land management systems was not visible at this scale. I obtained sketch maps of the Halang site (from Vega et al., 1994) and Upper Magsaysay site (provided by ICDAI) neither map shows individual land holdings. For the Imbarasan / Himamara site, I obtained an incomplete map of land holdings based on a preliminary survey conducted by the DENR.

Weather information

I obtained basic weather information from stations located reasonably close to all three sites. For the Imbarasan / Himamara site, I obtained monthly precipitation, monthly minimum, maximum and mean temperature, and the number of rainy days per month from PAGASA (the Philippine government department in charge of weather and climate records) records collected at the weather station in San Jose town (approximately 15 km from the study site). Data were available for the years 1981 to 1995 (PAGASA, 1996). For the Upper Magsaysay site, I obtained the same information. This information was collected at the PAGASA weather station in Infanta town (approximately 20 km from the study site). Data were available for the years 1961 to 1995 (PAGASA, 1996). Weather information for the Halang site was obtained from a 1990 study conducted by the Japan International Cooperation Agency (JICA, 1990) in the municipality of Jalajala. Since there was not a weather station located in Jalajala municipality, they estimated rainfall using data from the PAGASA weather station in Santa Cruz, Laguna, approximately 14 km southeast of Jalajala town. This data covered the years from 1969-1988.

Soils information

All three of the study sites fell into the category of "unclassified upland soils" in the Philippine Soil Survey (Dayot, 1986). As a consequence, no soils information was available for either the Imbarasan / Himamara or the Upper Magsaysay sites. However, I was able to obtain some soils information for the Halang site from an Australian Council for International Agricultural Research (ACIAR) funded cooperative project between SEARCA and the University of Queensland (UQ) that had conducted soil sampling and analysis on several farmer's fields in Halang. Soil samples were collected from seven different fields where the project subsequently set up demonstration plots. Six samples were collected and analyzed from each field. Samples were collected from the surface (0-20 cm) and subsurface layers (20cm - saprolite, usually no deeper than 30 cm in Halang). They were then analyzed for soil pH, organic matter percentage, extractable phosphorus, potassium, calcium, magnesium and sodium, cation exchange capacity (CEC), chlorine and sulfate concentration and water holding capacity at the laboratory run by the Analytical Services and Soil/Plant Test Kit Projects, Department of Soil Science, UPLB. Samples were also collected from an eighth farm but only limited analysis data was available (surface soil pH, percent organic matter, extractable phosphorus and potassium and water holding capacity).

Demographic data

I also obtained some demographic data for all sites, although the level of data differed greatly between sites. For the Imbarasan / Himamara site, I obtained a list of project participants that, in theory, should have been equivalent to a census of the area. However, discussions with local residents indicated that the list was significantly out of date. I also obtained population information at the *barangay* and municipality level from the 1995 census (RP-NSO, 1995). For Upper Magsaysay, I was only able to obtain census information at the *barangay* and municipality level (RP-NSO, 1995). For Halang, in addition to barangay and municipality level census data (RP-NSO, 1995), I obtained general demographic information from a participatory rapid rural appraisal (PRRA) conducted by SEARCA in 1994 (Vega et al., 1994) and supplemented by another SEARCA-UQ study in 1995 (Garcia et al., 1995). This information included population, number of households, and kinship patterns.

Previous research studies

Although I could not locate any research that had been conducted in either Imbarasan / Himamara or Upper Magsaysay site, I was able to draw on several research reports from activities in the Halang site. These included the report of the initial participatory rural appraisal activity conducted in 1994 (Vega et al., 1994), a follow-up socio-economic profile of the area (Garcia et al., 1995) and portions of a 1996 paper regarding agricultural marketing opportunities (Clark, 1996). These last two publications were outputs from an ongoing SEARCA-UQ project in the area. The PRRA report provided an extensive overview of the biophysical, socio-cultural and economic conditions in Halang. Additional details regarding *sitio* demographics, socio-economic conditions and land management systems were provided by Garcia, Tirol and Gerrits (Garcia et al., 1995). In his paper, Clark (1996) provided a brief assessment of current and potential marketing systems for agricultural products with an emphasis on the evaluation of potential alternative crops for the Halang area.

Informal interviews

Informal interviews were the primary data collection strategy used in the study. There were several reasons for this. The primary reason was that this was an exploratory study. Very little was known about these systems and so it was very difficult (and arrogant) to determine exactly what types of information would be important and which questions needed to be asked. Second, the first objective of this study was descriptive. Informal interviews provided a good way to collect detailed descriptive data about management systems. The second and third objectives also required complex and varied data that can often be better collected using informal approaches. During the one year of data collection, I conducted over 100 informal interviews. Multiple interviews were conducted with each of the 14 key informants and one or two interviews were conducted with a large number of other individuals and families.

Identification of key informants

All good field research requires informants who are willing to spend a considerable amount of time talking to the research and who will provide reliable information about the area of interest. These people are sometimes referred to as key informants. In this study, I initially set out to identify key informants met two general criteria. First of all, they were willing to talk to me, an outsider, at some length about nearly all aspects of their household livelihood and specifically land management system. Second, I wanted to find key informants in each community who used different management strategies in order to learn as much as I could about the range of different management strategies. The actual process of identifying key informants was different in each of the three communities.

Because I had lived in Imbarsan and Himamara for two years as a Peace Corps volunteer (1988-1990), it was easier to identify key informants at this site. I knew most of the residents from my previous time there. I was generally aware of the range of types of available land and land management practices followed in the area. As a consequence, after my first visit to the area and consultation with my closest friends there, I was able to identify six key informants and corresponding household livelihood systems. I subsequently identified a seventh informant in a later visit.

Although I lacked the familiarity and friendship ties in Halang that I had in Imbarasan / Himamara, the identification of key informants in Halang also proved to be relatively easy. This was largely because of the openness of the community and the presence of a well-liked technician from SEARCA. With his help, I identified five key informants.

Since I spent the least amount of time in this site, I was unable to identify specific persons as key informants. As a consequence, I had to rely much more on the ICDAI worker assigned to the area and on my observations. Fortunately, the ICDAI staff member was very well respected and so I was able to have very productive interviews with a number of local residents.

Interview data collection procedure

Following the suggestions of Marshall and Rossman (1988) and Rubin and Rubin (1995) I used a three stage note taking process for informal interviews. During the interview, I jotted down brief notes and important points. Although some interviewing texts suggest using a tape recorder or writing down long quotes from the person being interviewed, I opted to only jot down brief notes. The primary reason for this was the issue of privacy. I felt that I could get more reliable data if I could ensure my informants that any specific things they referred to were just between us. This was particularly important, I felt, because some very important activities in these sites (e.g. logging in Upper Magsaysay) were officially illegal, and because residents had been told that they should be using specific management practices by the government (in Imbarasan / Himamara) and by a development project (in Halang) and so might be reluctant to reveal the true reasons behind their present strategies if they felt word would get back to the government and they might lose other benefits.

In order to retain as much of the information contained in the conversation as I could, I expanded the short notes into a longer, more detailed, form as soon as possible after the interview and always within the next twelve hours (the evening of the interview day or immediately upon arising the next morning). Upon my return from the field (within 1-2 weeks), I retyped these hand written notes into a computer word processing program, adding additional information and editing them for clarity in the process.

Data collected

Informal interviews provided the wealth of information that forms the backbone of this study. Major types of information that I collected include: household assets and resources (e.g. land holdings, animals, etc.); agricultural, livestock and tree management strategies; other income and resource generating activities; household composition and structure; land use management histories; decision making strategies; goals and objectives; and income sources and expenses.

Formal survey

Near the end of the study, I decided to develop and administer a formal survey in order to collect a consistent set of basic land management system data from all the residents of each of the study sites. There were several reasons for this decision. First of all, a formal survey could provide a large amount of additional data in a relatively short amount of time. Since one of the main sources of validity in this type of research is additional data (triangulation), I felt that this additional data had the potential to improve the validity of the study. Second, a formal survey could be administered by others besides myself. This was very important in the Imbarasan / Himamara site due to safety considerations.

In order to administer the survey, I employed others to do the actual interviews. I developed the survey questions, translated them into Tagalog with the assistance of my wife (a native Tagalog speaker) and then hired two interviewers who pretested the survey in an area near Imbarasan / Himamara in late September, 1996. I revised the survey based on the pretest results and arranged for the survey to be administered in Imbarasan / Himamara and Upper Magsaysay. A total of 63 households were interviewed in Imbarasan / Himamara and 19 in adjacent areas in November, 1996. A total of 41 households were surveyed in Upper Magsaysay and 9 in adjacent areas, also in November, 1996. At that time, I decided to not to administer the survey in Halang since I thought I could obtain data from another survey conducted there in early 1995. However, I was unable to obtain the 1995 survey data and so arranged for a slightly modified version of the survey to be administered in Halang in September, 1997. A total of 42 households were interviewed. In all three sites, the number of households interviewed provides a reliable estimate of the total number of resident households in the area since the interviewers were all familiar with the sites and were requested to interview all resident households.

The time gap between November, 1996 when I concluded on-site data collection activities and supervised the administration of the formal survey in Imbarasan / Himamara and Halang and September, 1997 when the survey was administered in Halang was an area of concern. Since both bio-physical and socio-economic conditions can change from year to year, there was the chance that the Halang data would reflect significantly different conditions to those in 1996 when I conducted the on-site interviews and observations. However, I did not believe that this was a significant problem for two reasons: 1. The data collected in Septmber, 1997 still represented the 1996 crop season because 1997 crops had not yet been harvested, and 2. My friends and former colleagues in Halang indicated that there were no major differences between 1996 and 1997 in either the rainfall pattern or in key socio-economic variables such as prices.

The survey (Appendix 3) contained questions that addressed a variety of aspects of land management systems including: information on land holdings (size, upland or lowland, slope, soil type (local categories), primary use, history of settlement and tenure), annual crops (area planted, planting and harvest information, primary use, yield stability, input use), animals (type, number and use), trees (type, number and use), off-farm natural products (type, amount and use), demographics (family size, ages), and information on expenses, income and debt. The survey concluded by asking respondents to list the most important benefits and problems in their area. I coded the survey data and analyzed it on the University of Hawaii mainframe computer using the SAS software package, version 6.12 (SAS Institute, 1996). Details of the specific analyses performed are described later in this chapter and the results are presented in subsequent chapters.

Personal observation

Personal observation was also an important data collection strategy that I used in this study. I used personal observation primarily to validate information that I had been told in informal interviews and in order to inform my questions in subsequent interviews. It also served to help inform my development of the formal survey questionnaire. I also took a large number of photographs during the course of the study. Personal observations and photograph captions were initially noted in my working notebook at the time and were incorporated into my expanded field notes that I usually wrote either in the evening before going to bed or first thing the following morning. I was careful to distinguish between personal observations and interview information in all phases of my notes.

Soil sampling

The soil fertility status of a field, farm and community has a fundamental impact on the productivity of the agricultural components of a household livelihood system and serves to limit the management options available to residents. Since no standard data was available regarding soil properties in the Imbarasan / Himamara and Upper Magsaysay sites and the available data from the Halang site covered only one land use, I collected a small number of surface soil samples from selected locations in all three communities. The goal of this activity was to determine approximate levels of native soil fertility in different locally identified land types and landscape positions in order to develop a general idea of the situation in each community. I did not intend to collect comprehensive data on local soil fertility and my data only provided a very limited preliminary assessment.

In Imbarasan / Himamara, I collected a total of 18 soil samples from a variety of different landscape positions and land uses. These samples were analyzed for pH, percent organic matter, and extractable phosphorus, potassium, calcium and magnesium by the UPLB, Department of Soil Science, Analytical Services and Soil/Plant Test Kit Projects laboratory. In Upper Magsaysay, I collected a total of 9 samples that were analyzed at UPLB. In addition to the tests mentioned above, extractable aluminum levels were measured for all Upper Magsaysay samples with pH values less than 5.0. Although small amounts of extractable aluminum are sometimes detected in samples with pH levels as high as 5.5, the analytical services personnel recommended testing for extractable aluminum in samples with pH values of less than 5.0 since this represented the generally accepted point where exchangeable aluminum levels could become high enough to affect plant growth. Since some soil sampling data was already available for the Halang site, I concentrated my sampling activities on landscape positions and land uses that had not been sampled by the previous project. I collected a total of 10 samples and had them analyzed at the UPLB soil testing laboratory.

Analysis procedures

In this section, I describe the analysis procedure used to meet the study objectives. This section is structured by objective. For each objective, I discuss the data to be analyzed, operational definitions of the specific measures (if any) and the overall analysis procedure. Results of the analyses are presented in chapters four, five and six.

Objective number one: livelihood system description

The first study objective was to describe the common livelihood strategies employed by residents in the three study communities. However, in order to describe the household management systems, it was also important to describe the three study communities.

Community description

I used several pieces of the available data discussed above to develop descriptions of the study communities. Community location was determined from existing data as was the general rainfall pattern. This data was verified through consultation with local residents. Existing soils information and the soil sampling and testing conducted for the study provided information on soil fertility status, and my observations and respondents replies to survey questions provided information on site topography.

The bulk of the information used to describe the communities was derived from survey responses to questions on land holding size, crops grown, yields, animals, trees, and a variety of other issues. Survey data was used to calculate mean and median values and ranges for numeric variables and frequencies for nominal and ordinal variables. These survey responses were analyzed in the context of my knowledge of the communities gained through interviews and personal observation. Since the survey was conducted at the end of my research, data collection was an iterative process. I used my knowledge of the communities to inform the development of survey questions which in turn increased my knowledge of the community.

Description of example household livelihood systems

Description of the example household livelihood systems was an important prerequisite to the sustainability analysis. The example household livelihood systems descriptions included the same types of information that was presented in aggregate form for the community. Where possible, information at the household level was derived from a combination of information provided during informal interviews and information from the formal survey. However, as discussed in the earlier section on identification of example households, I did not have key informant representatives of all household types. As a consequence, some descriptions were based much more strongly on survey responses and community averages. The specific mix of informal interviews, formal surveys and other data used for each example household was included in the example household descriptions (Appendix 2).

Objective number two: sustainability assessment

The second study objective was the assessment of system sustainability at both the household management system level and the community level. In a previous section, I identified the nine agroecosystem properties that I used as variables to assess the concept of system sustainability, and I identified a set of potential measures to assess value of each of these variables. In this section, I provide specific operational definitions of each of these measures grounded in the available data.

Productivity assessment

System productivity was assessed at both the community and household levels.

Community

At the community level I used three productivity measures: the average household income, the average per capita income, and the relative crop yields based on national and provincial averages. These measures were operationally defined as follows:

1. *Average household income*: The average of the reported household incomes in the community from the formal survey responses expressed as a percentage of

the national average rural income. Average annual income was rated high if it exceeded 125% of the national mean rural annual income level of P53,500 (RP-NSCB, 1997); moderate if it was between 75% and 125% of the national mean; and low if it was less than 75% of the national mean.

2. *Per capita income*: The average per capita income for the community was computed by dividing the total community income reported on the formal survey by the total number of residents reported on the formal survey. The average per capita income was rated high if it exceeded 200% of the national poverty level of P8,885 (RP-NSCB, 1997); moderated if it was between 100% and 200% of the poverty level; and low if it was under 100% of poverty level.

3. *Relative crop yields based on national averages*: The community average yield of all annual crops grown by more than 30% of area residents expressed as a percentage of the national or provincial average yields. First, the percentage value was computed separately for each crop that met the 30% threshold level (4 in Imbarasan / Himamamra, 4 in Halang, 3 in Upper Magsaysay). Crop yields were compared to national average yields. The national average yield based on 1994-1996 harvests (RP-NSCB, 1997) was used for flooded rice, maize, mung bean, banana, and garlic. National average yields based on an unspecified time period were used for taro (PCARR, 1977) and dryland rice (Pandey, 1996). Since national averages were unavailable for coconut and bitter melon, average yields from Quezon province (RP-NSO, 1990) were

used. Data from Quezon province was used for all households because national data and provincial data from Rizal and Occidental Mindoro provinces were unavailable. The overall measure was rated high if the average of the two percentages was over 125%; moderate if the average was between 75% and 125% ; and low if the average was below 75%.

The overall community productivity was evaluated using an additive index with high = 3 points, moderate = 2 points and low = 1 point. Since there were three measures, the index ranged from a minimum of 3 to a maximum of 9. A community was rated high if it had an index value of 8 or 9; moderate if it had an index value of 5, 6 or 7; and low if the index value was 3 or 4.

Household

I used five measures to define household productivity: total annual income, annual per capita income, total monetary value of harvested crops per hectare, total monetary value of harvested crops per capita and relative crop yields based on national averages. The measures were operationally defined and will be rated as follows:

1. *Total annual income:* the total annual income estimated by the household either during an informal interview or in response to a survey question. Household ratings were computed using the same criteria used for rating average annual income at the community level.
2. *Annual per capita income*: the total annual income from #1 divided by the number of persons in the household. Household ratings for this measure were

computed using the same criteria used for rating average per capita income at the community level.

3. *Annual income per hectare:* the total annual income from #1 divided by the total land available to the household. Income per hectare was rated high if it exceeded 125% of the average income per hectare for the Southern Tagalog Region (which includes all three study sites) of P22,000 (calculated from RP-NSCB, 1997 and RP-DA-BAS, 1994). The measure was rated moderate if it was between 75% and 125% of the regional average, and was rated low if it was below 75%.

4. *Total monetary value of annual crops*: The total yield of edible crops produced by the household converted into pesos based on local 1996 prices. This was based on data provided either through the formal survey or in informal interviews. This measure was rated by comparing the value to the national average annual income level. The same thresholds used for total annual income (measure #1) were used for this measure.

5. *Relative crop yields based on national averages:* Relative yields (on a per hectare basis) of the two major annual crops or perennials identified in the household survey as a percentage of the national or provincial average yields. Household ratings for this measure were computed using the same criteria used for relative crop yields at the community level. However, I only assessed the two crops cited by the household as being the most important (survey question

10). The overall rating was based on the average percentage calculated for these two crops.

The five measures were additively combined with high = 3, moderate = 2 and low = 1. The additive index ranged from a minimum of 5 to a maximum of 15. If the total was in the highest one-third of the index (12-15), the household was rated high. If the total was in the middle one-third (9-11), the household was rated moderate. And, if the total was in the lowest one-third (5-8), the household was rated low.

Stability assessment

Stability was assessed at both the community and household levels.

Community

Given the short time period of this research and the lack of historical data, I had a difficult time developing suitable measures to assess stability at the community level. I finally developed a four component measure based on the responses to survey questions 11.1 and 12.1, an assessment of the comments made by residents in interviews, and my own personal assessment. Each of these four measures was rated high, moderate or low and they were combined using an additive index as in the case of productivity. Since this index had four parts, it ranged from 4 to 12. A value of 10, 11, or 12 was rated high. A value of 7, 8 or 9 was rated moderate. And a value of 4, 5 or 5 was rated low.

It was difficult to relate the responses to survey questions 11.1 and 12.1, "How have your yields changed from years past?" to a stability index. Due to an error in the survey design, the potential responses: "More or less stayed the same," and "Up and down – there have been good years and bad years," were not mutually exclusive. As a consequence, I considered the selection of "More or less stayed the same" (option "c") as an indicator of high stability and "Up and down – there have been good years and bad years" (option "d") as an indicator of moderate stability. I considered options "a" and "b" (generally decreased and generally increased) as indicators of low stability.

I computed the survey question based weighted average stability assessment for the community by first multiplying the number of "d" responses by 3 (for high); the number of "c" responses by 2 (for moderate) and the number of "a" and "b" responses by 1 (for low) and dividing by the total number of responses. This index, ranging from 1 to 3, was computed for both question 11.1 and question 12.1. I then computed the average of the two questions. If the index value was less than 1.66, it was rated low. If it was between 1.66 and 2.33 it was rated moderate. And if it was over 2.33, it was rated high.

Household

The problems discussed above also applied to stability assessment at the household level. So, I decided to apply a similar approach to the one used at the community level. At the household level, the first component of the stability index was based on question 11.1 and the second on question 12.1. These two index components were assessed as follows: if the response was "d" the rating was high; if the response was “c”, the rating was moderate; and if the response was “a” or “b” the rating was low.

The two survey-based components were additively combined with the researcher’s stability assessment (high, moderate or low) to develop an additive index using the procedure described for the community level. Because this index had only three components, it ranged from a minimum of 3 to a maximum of 9. Households with index values of 3 or 4 were rated low. Those with values of 5, 6 or 7 were rated moderate, and those with values of 8 or 9 were rated high.

Maintenance assessment

Maintenance was assessed at both the community and household levels.

Community

At the community level, I used four indicators to assess maintenance. The first two indicators were based on survey responses. The third was based on comments from informal interviews, and the fourth was based on my personal observations.

Because of the problem with non-exclusive responses to questions 11.1 and 12.1 discussed in the stability rating section above, I developed a maintenance rating from these responses using the following procedure. First, I omitted all “d” responses, “Up and down – there have been good years and bad years,” since they provided neither a positive nor a negative assessment of maintenance. I then calculated the number of “b” (generally increasing) and “c” (generally steady) responses as a percentage of the total remaining responses. Both questions were rated as follows. If the value was greater than 66 percent, the rating was high. Values between 33% and 66%, inclusive, were rated moderate and values less then 33% were rated low.

The two survey-based index components were combined with the other two components from the interview and from research observations using the same additive index procedure discussed above for stability. Since there were four index components, the index ranged from a minimum of 4 to a maximum of 12. Index values of 4-6 were rated low. Values of 7-9 were rated moderate, and values of 10-12 were rated high.

Household

Assessment of maintenance at the household level was much more difficult. Survey responses were only informative in 3 of the 20 example households. As a consequence, I developed two other index components. The first was based on erosion risk. I assessed the parcels described in the survey using the following criteria: if the parcel was flat, erosion risk was rated low. If the parcel had gentle slope and was planted to annuals, erosion risk was rated moderate; if planted to perennials, erosion risk was rated low. If the parcel had a moderate or steep slope, erosion risk was rated high if planted to annuals and moderate if planted to perennials. Ratings from each parcel were averaged to develop an overall erosion risk rating. The second index component used was the presence or absence of a nitrogen fixing crop in the management system.

The index components were combined into an overall index using the following procedure: 1. A household was given -2 points if they responded "a", yields are decreasing, to question 11.1 or 12.1. The household was given 2 points if they responded "b", yields are increasing, or "c", yields are steady to either question. Otherwise no points were given 2. The household was given 0 points if the erosion risk was high, one point if risk was moderate; and 2 points if risk was low. 3. The household was given 1 point for the presence of a nitrogen fixing species. 4. The household was given 3 points for a research rating of high, 2 points for moderate and 1 point for low.

This resulted in an index that could, in theory, range from -4 to 10. However, when the procedure was applied to the data, the index range was much smaller (1-6). So, overall household level maintenance ratings were based on this smaller index range. Households with index values of 1 or 2 were rated low. Households with values of 3 or 4 were rated moderate, and those with values of 5 or 6 were rated high.

Resilience assessment

As in the case of maintenance and stability, resilience was also assessed at both the community and household levels.

Community

At the community level, I used four components to develop an overall resilience rating. The first two components were based on survey questions. The third was based on comments from interviews, and the fourth on my observations. The first two components of the resilience rating were derived from responses to survey questions 11.2 and 12.2. I computed the percentage of community respondents who chose response "e", "Whatever happens, you always get something," to the questions. These two index components, one for each question, were rated high if more than 66 percent indicated response "e", moderate if between 33 and 66 percent, inclusive, chose "e" and low if less than 33 percent chose "e". These two ratings were combined with an overall assessment of interview comments (high, moderate or low) and my personal assessment (high, moderate or low) using an additive procedure with high = 3, moderate = 2 and low = 1. This resulted in an index that ranged from a minimum of 4 to a maximum of 12. Index values of 4, 5 or 6 were rated low. Values of 7, 8 or 9 were rated moderate, and values of 10, 11 or 12 were rated high.

Household

I rated resilience at the household level using three of the four index components discussed above for the community level: the two survey questions and the researcher's personal assessment. I rated the two survey questions as follows: the household was given 3 points if the responded "e," "Whatever happens, you always get something,"; 2 points if they responded "d," "One year in 20,"; 1 point if they responded "c," "One year in 10," and 0 points if they responded "b," "One year in 5," or "a," "Every other year." I added these two components and then added 3 points if my personal rating was high, 2 points if it was moderate and 1 point if it was low. This resulted in an index with a range from 1 to 9. Households with index values of 1, 2 or 3 were rated low. Values of 4, 5 or 6 were rated moderate, and values of 7, 8 or 9 were rated high.

Equitability assessment

In this study, I did not set out to investigate intra-household dynamics. Therefore, equitabililty was assessed only at the community level. As suggested by the UNDP (1990), I calculated Gini ratios for two variables, land holding size and total household income. In addition, I computed the ratio between the average per capita income for the richest 20% of the population and for the poorest 20% of the population. These values were rated based on information from the World Bank (1997). For the Gini ratio, values from 65 countries were considered. The rankings in this study followed the distribution of these 65 values. Gini ratios of less than 0.34 corresponded to the lowest one-third of all values and so were rated as having high equitability. Gini ratios between 0.34 and 0.45 represented the middle one-third of values and so were rated as having moderate equitability. Ratios of over 0.45 represented the highest one-third of values and were rated as having low equitability. A similar procedure was used for the ratio between the richest and poorest 20% of the population. The ratios of 6.0 and 10.0 divided the 84 countries listed into three, approximately equally sized, groups. I used this division and assessed the ratios calculated in this study as follows: a ratio of less than 6.0 was rated as high equitability; a ratio of between 6.0 and 10.0 was as moderate equitability and a ratio of greater than 10.0 was rated as low equitability.

The three ratings were used to develop an additive index with high = 3, moderate = 2 and low = 1. Since this index had three components, it ranged from 3 to 9. A value of 3 or 4 was rated low. A value of 5, 6 or 7 was rated moderate; while a value of 8 or 9 was rated high.

Autonomy assessment

System autonomy was assessed at both the community and the household levels.

Community

Unfortunately, I was unable to develop specific, quantitative indicators of community level autonomy. Instead, I assessed the level of autonomy as high, moderate or low based on my synthesis of a number of community-wide factors including: the general community use inputs for both agricultural and household needs, community dependence on outside markets for livelihood and community self-sufficiency in rice and other essentials.

Household

At the household level, I used four measures of autonomy. The measures were: percentage of total income derived from off-farm sources, ratio of market vs subsistence production, level of rice self-sufficiency, and use of external inputs including fertilizer, pesticides, non-family labor and credit. These measures were operationally defined as follows:

1. *Percentage of total income derived from off-farm sources*: This was based on reported income on the formal survey. If the percentage was less than 33%, this component of autonomy was rated high, if between 33% and 66% inclusive it was rated moderate, and if over 67% it was rated low.
2. *Ratio of market vs subsistence production*: This was calculated as the ratio of the number of (annual crops + perennials + animals) sold vs the number used in the household. Values were based on responses to the formal survey. If the ratio was below 0.5 then this component of autonomy was rated as high. If the ratio was between 0.5 and 1.5, inclusive, this index component was rated moderate. If it was above 1.5, the index component was rated low.
3. *Level of rice self-sufficiency*: This was based on both informal interviews and survey information. If the household indicated a rice surplus, this component of the overall autonomy rating was rated high. If the household was self-sufficient, it was rated moderate. If the household did not produce enough rice for household consumption, this component was rated low.
4. *Use of external inputs*: This was also based on information from survey and informal interviews. I gave a household a score of 1 point for use of each of the following inputs: fertilizer, pesticide, hired labor and credit. Households with 3 or 4 points were rated low; 2 points were rated moderate and 0 or 1 point were be rated high.

These four ratings were additively combined with high = 3, moderate = 2 and low = 1. The overall index ranged from 4 to 12 and so, households with index values of 4, 5 or 6 were rated low. Those with values of 7, 8 or 9 were rated moderate, and those with values of 10, 11 or 12 were rated high.

Solidarity assessment

As in the case of equitability, I did not collect sufficient intra-household data to effectively assess solidarity at the household level. At the community level, I instead relied on residents' reports of community cohesion. These included comments about community cohesion and cooperation from the formal survey as well as comments from informal interviews. If these reports were frequent and widespread, I rated community solidarity as high. If the issues were mentioned less frequently, I rated solidarity as moderate. If these issues were seldom mentioned, I rated solidarity as low.

Diversity assessment

I assessed system diversity at both the community and household levels.

<u>Community</u>

At the household level, I used three measures of diversity: species abundance, number of guilds and number of income sources. These measures were operationally defined as follows:

1. *Species abundance*: This was based on community averages obtained from the formal survey data. This variable was composed of three sub-variables for

annuals, livestock and perennials. The three sub-variables were rated as follows: annuals -- 2 species or less was rated low, 3-5 species was rated moderate, over 5 species was rated high; livestock -- 2 species or less was rated low, 3 or 4 species was rated moderate, over 4 species was rated high; perennials -- 4 species or less was rated low, 5-13 species was rated moderate, over 13 species was rated high. The three sub-variables were combined using an additive index with high = 3, moderate = 2 and low = 1 in order to create an overall species abundance rating. Since the index ranged from 3-9, values of 3 or 4 were rated low, values of 5, 6 or 7 were rated moderate and values of 8 or 9 were rated high.

2. *Number of guilds*: This was also based on community averages from the formal survey. A guild was defined previously as a set of activities have similar attributes or that perform a similar function in the system (e.g. cereal crops, draft animals) (Dalsgaard and Oficial, 1997). If the average number of guilds for the community was less than 5, guild diversity was rated low. If the average was between 5 and 10 inclusive, guild diversity was rated moderate, and if the average was over 10, guild diversity was rated high.

3. *Number of income sources*: This was the community average of the number of income sources reported in the formal survey. If the average was less than 1.66, income source diversity was rated low. If the average was between 1.66

and 3.33, inclusive, income source diversity was rated moderate. And if the average was over 3.33, income source diversity was rated high.

The three measures of diversity, overall species diversity, guild diversity and income source diversity, were combined using an additive index with the same form as the indices discussed previously. This index ranged from 3-9. So, communities with index values of 3 or 4 were rated low; those with index values of 5, 6 or 7 were rated moderate; and those with index values of 8 or 9 were rated high.

Household

I assessed diversity at the household level using the same measures used at the community level. However, the three measures were assessed using values from individual households instead of community averages. The same rating criteria were used at the household level that were used at the community level, and the three measures were combined to develop an overall diversity index using the same procedure as I used at the community level.

Adaptability assessment

As with many of the variables discussed in this section, adaptability was difficult to assess at either the household or community level.

Community

I rated community adaptability as high, moderate or low based on my own opinions informed by discussions with residents. I rated household system adaptability as high, moderate or low also based on my own opinions and observations that were informed by discussions with residents. I focused on community-level adoption of management system changes in the past (i.e. adoption of new crops) and my perceptions of the general receptiveness of the community to new ideas and systems that might better meet their needs and goals.

Household

Household level adaptability ratings were also based on my own personal observations and opinions informed by interviews with residents. I specifically considered household reports of system changes in the past and of ongoing experimentation as indicators higher levels of adaptability. Significant evidence of ongoing experiments and adaptation in the past resulted in a household adaptability rating of high. Limited evidence of either of these activities resulted in a household rating of moderate; while little or no evidence of these activities indicated lower household adaptability. However, even in the absence of specific evidence, the fact that the current residents in all three study communities had migrated there in the past and had continued to survive over the past 10-30 years indicated that virtually all households had at least moderate levels of adaptability.

Overall sustainability assessment

I used three different methods of combining the nine system variables to determine a composite sustainability rating for each community. The three methods were a simple additive model, a "law of the minium" model and a dominant value of component ratings (mode-based) model. The same three methods were used to combine the seven applicable system variables to determine a composite sustainability rating for each of the 20 example households.

Additive model

The first method I used to combine the nine variables was a simple additive model. An additive model assumes that all variables have equivalent importance and is the approach most often used in the absence of generally accepted criteria for weighting different factors. In order to compute the overall rating, I added up the total ranking points for each system after assigning a value of 3 to "high" ratings, 2 to "moderate" ratings and 1 to "low" ratings. This produced a value ranging from a minimum of 9 to a maximum of 27. Systems with values from 9-14 were rated low, 15-21 were rated moderate and 22-27 were rated high. Since only seven variables were applicable at the household level, the index ranged from a minimum of 7 to a maximum of 21. Households with values from 7-11 were rated low, 12-16 were rated moderate and 17-21 were rated high.

Law of the minimum

The law of the minimum is an approach that has been used to combine multiple variables was based on the premise that a system is only as good as its weakest component. This was analogous to the failure analysis procedure used in mechanical and engineering systems. I applied this approach to the assessment of an overall sustainability rating. If the community or household had at least one variable rated low, the overall sustainabilty rating was low. If no variables were rated low and at least one variable was rated moderate, the overall sustainability rating was moderate. If all variables were rated high, the overall sustainability was rated high.

Dominant value

The third methodology used was the dominant value model. This model is based on the premise that the behavior of the larger system is likely to be most strongly influenced by the most common behaviors of its components. The overall sustainability rating was determined by the most common value of the ratings of the component variables. If the most common value among the nine (or seven at the household level) variable ratings was high, the overall rating was high. If it was moderate, the overall rating was moderate. And if it was low, the overall rating was low.

Objective number three: modeling household decision making

The third study objective was to model some of the major household decision making strategies using decision trees, a simple decision making model. In this section, I discuss the procedures used in model development. For clarity, I have divided them into two parts: identification of decisions to model and model construction and validation.

Identification of decisions to model

The first necessary activity in this modeling procedure was the identification of decisions to model. I had hoped to be able to systematically model some of the overall household livelihood management decisions. Unfortunately, since I did not specifically set out to model decision making as part of the research, I did not have the data necessary to develop decision making models for general household livelihood strategies. Instead, I chose a two part approach that, although it did not provide a complete picture of household decision making, provided important information and insights into household decision making in the area of land management.

For the first part of this analysis, I chose to develop models of the major land management decisions for households in the three study communities. These decisions were primarily focused on annual crops but also included perennials. Since many of the theoretical models of sustainable upland systems have suggested that perennial species provide a basis for more ecologically sound and potentially more productive systems in many upland areas, the second part of the analysis investigated specific cases of households that have adopted unique and interesting land management strategies where perennial species were an important component. Although these case studies presented situations that were unique to one specific household, taken together, they provided insights into why certain residents had chosen to adopt perennial-based strategies.

Model development and validation

The decision tree models were developed using the procedure outlined by Gladwin (1989). Following this procedure, household goals, preferences and constraints became the decision nodes between the branches of the decision trees. The decision trees were constructed by connecting these nodes in a logical fashion that lead up to the decision itself. In the simple decision trees that I used in this study, the inability to meet a constraint resulted in a negative response to the overall decision. Consequently, an affirmative decision resulted only when all the criteria in the decision tree were met.

Although Gladwin (1980) suggested that the best way to increase the validity decision tree models was to develop them using a multi-stage, iterative process with interaction between the research and the persons whose decisions were being modeled, this approach was not possible for this study due to time and cost considerations. So, the decision trees developed for this analysis represented a first approximation of household decision making in the three communities. I attempted to validate the decision trees for each community using data from the formal survey. However, I also used the formal survey results in model development. So, this did not provide a true validation. In addition, since the survey was not developed to validate the model, all model components were not included in the survey. This further decreased the reliability of verifying the model using the formal survey data.

Identification of decision case study households

For the second part of this section of the analysis, I identified seven decision case households. All of these households were using systems with a strong perennial component. The households were identified based on my personal observations and information provided in informal interviews. Household management system descriptions and descriptions of how and why they had developed these management systems were based on informal interviews and my personal observations of the management systems.

Chapter 4
The people and the places

Before assessing the sustainability of existing household livelihood systems and before modeling household strategies, it was necessary to describe the people, the management systems, and the communities that were the sites of this study. This chapter is divided into four sections. The first three sections discuss the three study communities. The chapter concludes with a discussion of how the systems described for the three study communities compare to upland livelihood systems that have been described in other research from the Philippines and elsewhere in Southeast Asia.

The first three sections follow the same pattern starting with description of the site at the community level and finishing with descriptions of the example household livelihood systems that were the focus of the household-level sustainability analysis. The first section discusses Imbarasan / Himamara; the second, Halang; and the third, Upper Magsaysay. As noted in the methods chapter, the information used in these community descriptions came from informal interviews with residents, the formal surveys of a saturation sample of residents in each community and secondary data where available. The overall procedure for the identification of the example households in each community followed the procedure described in the previous chapter. The specific data used in each case is discussed in the context of the individual community and household descriptions.

Site #1: Imbarasan and Himamara, Mapaya, San Jose, Occidental Mindoro

Community level

This first study site consisted of two small upland *sitios*, Imbarasan and Himamara, located in *barangay* Mapaya, in the municipality of San Jose, Occidental Mindoro. Mindoro is one of the major Philippine islands and is located south of the central part of the island of Luzon (Figure 4.1). The province of Occidental Mindoro occupies the western half of the island. The municipality of San Jose is located in the southwestern corner of the province. Imbarasan and Himamara are located adjacent to each other in the foothills between 10 and 15 kilometers east-northeast of San Jose town proper (Figure 4.2).

Physical environment

Terrain

The land in both communities consists of small valleys bisecting relatively low but steep hills ranging in elevation from 20 to 200 meters above sea level. Imbarasan is located nearer the ocean and contains a greater percentage of valley land than Himamara.

Climate

The entire province of Occidental Mindoro is characterized by a strong monsoonal climate. Although the average annual rainfall in the San Jose area is approximately 2400 millimeters (PAGASA, 1996), rainfall is strongly seasonal

Figure 4.1. Philippine map showing location of study communities
(1) Imbarasan / Himamara, Mapaya, San Jose, Occidental Mindoro
(2) Halang, Bayugo, Jalajala, Rizal
(3) Upper Magsaysay, Infanta, Quezon

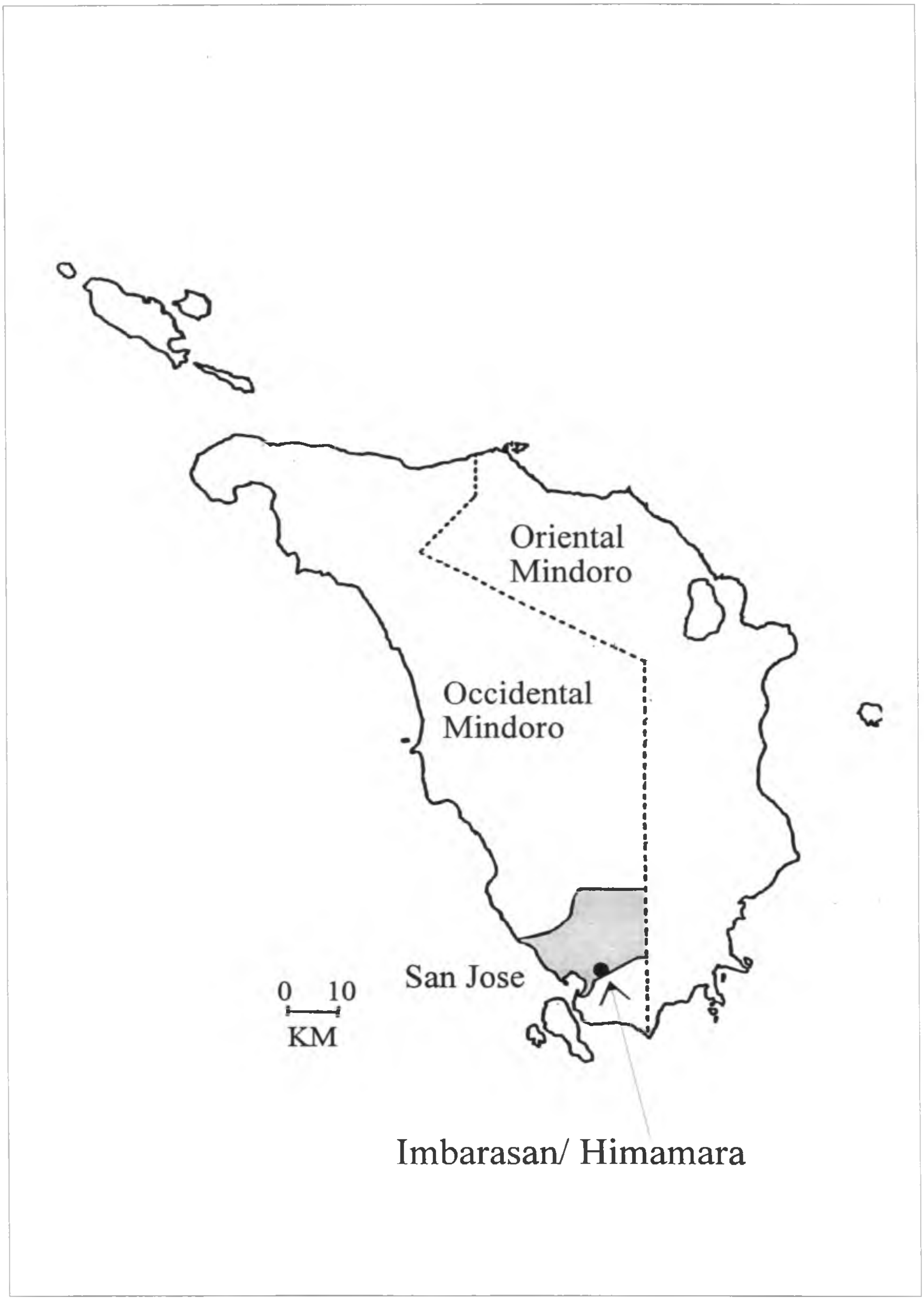


Figure 4.2. Location of Imbarasan / Himamara

(Figure 4.3). Average monthly rainfall from June - September exceeds 400 mm while monthly averages from January - April are less than 20 mm. Although rainfall in Occidental Mindoro generally increases with increasing elevation, farmer reported rainfall and the author's experience indicated that the amount and distribution of rainfall in Imbarasan and Himamara did not differ significantly from San Jose town.

Soils

The soil types found in the area are a function of both landscape position and parent material. In Imbarasan, the upland soils have developed from sandy parent material (residual sand dunes). These soils were sandy loam - sandy clay loam texture and generally low fertility, especially after cropping. In Himamara, the upland soils have developed from a mixture of sandy and calcareous parent material. These soils were generally loam-clay loam in texture and had much higher fertility than the sandy soils found in Imbarasan. Lowland soils in both areas were clays or silty clays developed largely from alluvial materials.

The local classification of soils generally paralleled the above groupings; however, there were some differences. Residents classified soils into four types: *Lupa sa baba* or *lupang palay* (lowland soil or rice soil), *lupang buhangin* (sandy soil), *lupang mestizo* (mixed soil), and *lupang puro* (pure soil). Soils were also further classified by color with darker brown and black soils identified as being the most fertile. Lowland soils were located exclusively in valley areas. The sandy soils were

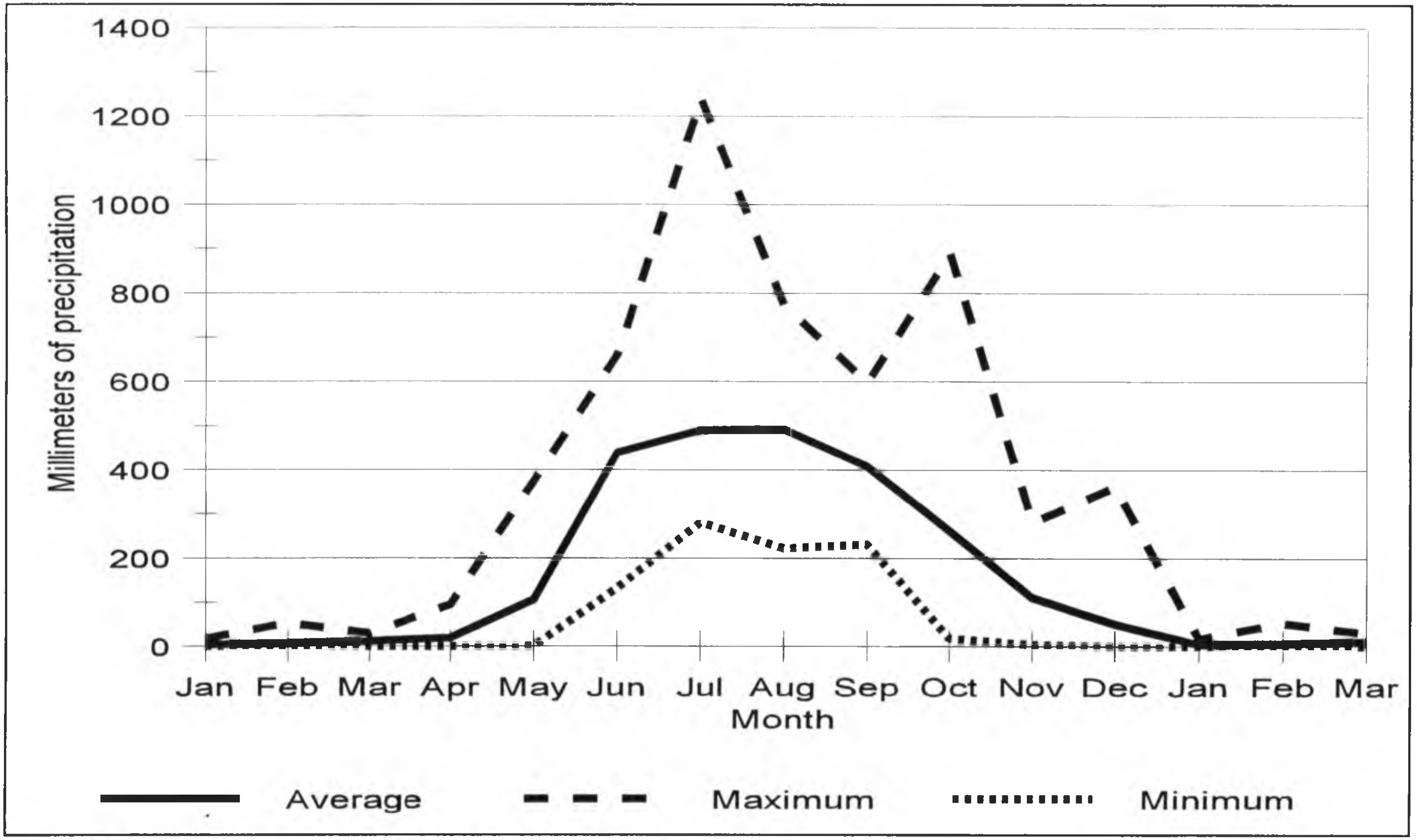


Figure 4.3. Rainfall pattern in San Jose, Occidental Mindoro

found in uplands in the lower parts of Imbarasan. Mixed soils were found in uplands in upper Imbarasan and lower Himamara. The pure soils were found in the upper parts of Himamra closest to the mountains.

I obtained and tested soil samples from different landscape positions and from different land uses (Table 4.1). Although it was impossible to characterize the soils in materials and nutrients eroded from the hillsides, these soils were characterized by moderate pH, adequate organic matter levels and adequate, although not high, levels of the major nutrients (P, K, Ca, Mg). The soils of upper Himamara ("pure" soils) were also very fertile. These soils developed over calcareous parent material and had high cation levels and organic matter although they were relatively low in phosphorus. The mixed soils were less fertile than the previous two groups and were generally sandier. The least fertile soils were the sandy soils of lower Imbarasan. These soils developed over residual sand dunes and were characterized by low pH and a very low level of common mineral nutrients. Although only a small number of soil tests were conducted, there appeared to be a negative effect of clearing and cultivation on the mixed and sandy soils. However, this effect was not apparent on the lowland and "pure" soils.

Table 4.1. Soils in Imbarasan and Himamara

Sample location	pH	% OM Walkley-Black	P (ppm) Bray 2	K (me/100g) NaOAc	Ca (me/100g) NaOAc	Mg (me/100g) NaOAc
Valley (*lupa sa baba*) (3 samples, 1 only for Ca, Mg)	6.4-8.0	2.0-2.4	3.9-9.5	0.36-0.38	17.55	2.70
Imbarasan Hillside (*lupang buhangin*) (4 samples)	5.1-5.3	0.72-0.85	2.1-2.5	0.12-0.22	1.2-2.7	0.35-0.86
Imbarasan /Himamara Hillside (*lupang mestizo*) Cropped (2 samples, 1 for Ca, Mg)	5.4-5.6	1.3-1.4	2.3-6.7	0.22-0.37	3.71	0.82
Imbarasan /Himamara Hillside (*lupang mestizo*) Fallow (3 samples)	5.6-6.5	1.9-3.4	3.5-24.6	0.27-0.45	3.5-7.2	0.23-1.5
Himamara Hillside (*lupang puro*) (3 samples)	5.5-6.3	2.4-4.4	6.3-8.1	0.7-1.0	15.5-18.9	2.6-3.9

Socio-political environment

Land status / classification

Even though Imbarasan and Himamara both included significant areas of flat, valley land, the entire area of both communities was classified as forest land by the Philippine government. As a result, the land, although primarily used for agriculture, was under the jurisdiction of the Department of Environment and Natural Resources (DENR). Imbarasan and Himamara were administered by the DENR as an Integrated Social Forestry Program (ISFP) site. Since the area was forest land, residents were barred from obtaining clear title to their holdings under Philippine law. In order to provide residents with some tenure security, the primary function of the ISFP was to provide residents with renewable, 25 year leases (called a CSC or Certificate of Stewardship Contract) to their holdings. While these leases could not legally be sold, they could be inherited. There was also a recognized and grudgingly accepted (by the local government field technician) gray market for land sales in Imbarasan / Himamara and in most other upland communities. Under the ISFP, resident households (husband and wife) were limited to 5 hectares of land. An additional 5 hectares could be claimed by children over 16 years of age. However, several couples in Imbarasan / Himamara had claimed two separate parcels because the wife received a CSC under her maiden name.

In return for receiving a CSC, residents were expected to follow the advice of the local field technician on how to manage their lands so as to reduce environmental degradation. In theory, residents could lose their CSC for failing to manage their lands appropriately; however, this rule had not, to my knowledge, been applied in Imbarasan / Himamara. The ISFP also conducted farmer trainings on alternative management practices such as alley cropping and distributed tree seedlings. As mentioned above, a field technician was assigned to the area; however, he did not live in the area and due to the wide scope of his tasks, both in the office and in the field, he was seldom in the area more than a few days each month.

Under Republic Act 7160 (the Local Government Code) passed in 1991 (Republic of the Philippines, 1991), many of the functions of the DENR, including the ISFP were turned over to the municipal government. In practice, this change has made little difference in San Jose in general and in Imbarasan / Himamara in particular. I was told that the municipal government lacks the staff and expertise to take over the program and lacks the funding to hire appropriate staff. As a consequence, the DENR continued to administer the ISFP as it did before the passage of the local government act.

A total of 46 resident households (73%) reported that they possess some sort of papers to certify their rights to the land they now manage. The most common type of certification was a CSC (76%). In spite of the areas' classification as forest land, 17% of those with papers had title documents. These holdings were all located in Imbarasan and were probably titled before the area was classified as forest land in the

1960's. The remaining 7% had either a tax declaration or a non-binding certificate of occupancy obtained from the barangay captain.

Governance

Imbarasan and Himamara were 2 of the 16 *sitios* that made up the *barangay* of Mapaya which was part of the municipality of San Jose. The *barangay* was governed by a seven member council elected by all registered voters in the barangay (men and women 18 and over). The person who received the most votes in the election became the chairperson of the council and was referred to as the *barangay* captain. The captain was expected to lobby for the *barangay* and for *barangay* residents with the municipal government, to mediate minor disputes between residents, and to assist residents in their dealings with government agencies. The *barangay* council also retained a small (one or two person) security force (called the *barangay tanod*). These officials did not have formal police powers but were expected to maintain peace and order, primarily through persuasion and negotiation. At the time of the study, there were no residents of Imbarasan or Himamara on the *barangay* council although there had been in the past. All council members came from the flat, rice growing, parts of the *barangay* located near the main road and toward the ocean from Imbarasan and Himamara. However some of the older community residents were regularly consulted by the barangay captain regarding community issues. As part of the municipality of San Jose, the area was under the jurisdiction of the mayor and municipal council.

Infrastructure and services

In order to better understand the situation in the study communities, it was also important to understand the level of infrastructure and the services available to local residents.

Roads and transportation

Access to much of the area was difficult, especially during rainy season. An all-weather road ran between 2 and 5 kilometers from the southern / southwestern boundary of the area and was serviced by public transportation (passenger *jeepney*) to and from San Jose at least twice daily. A trip to San Jose from the communities took approximately 1 hour not including time to get from the farm house to the road and waiting time for the *jeepney*. Most residents went to town for the entire day, leaving in the morning and returning in the afternoon. The fare to and from San Jose was based on the road distance and ranged from P5-P10 depending on the part of the *sitio* and road junction chosen. Children rode for one-half of the adult fare, infants were free, a sack of produce was charged the same as a person, and rates for other products were generally similar and were negotiated with the driver. If a farmer had a lot of produce, they might rent an entire jeep for the trip for approximately 500 pesos (again dependent on the cargo etc.).

Even though the actual travel time via *jeepney* was relatively short, the distance from individual land holdings to the road must be traversed on narrow and often muddy trails on foot or by water buffalo and could take several hours. As a consequence, transport of farm products to markets was often extremely difficult and costly. There had been talk of extending and improving an existing trail from the main road into the southwestern corner of Imbarasan. However, it had been promised for so long, that the construction of this *barangay* road had become a bit of a running joke among long time residents. During dry season, there was access by passenger *jeepney* (one trip daily) to the eastern edge of Himamara. In addition, *jeepneys* or trucks could enter some of the lowland sections of both Imbarasan and Himamara during dry season using poorly maintained trails in order to pick up a cargo of rice.

The municipality of San Jose was accessible to the rest of the country by both air and sea. The San Jose airport was serviced by regular flights to Manila on Philippine Airlines. During this research, service switched from daily 737 jet flights to daily Fokker 50 turboprop flights. Via jet, the flying time to Manila was approximately 25 minutes, by turboprop, approximately 50. However, airfare and shipping by air were prohibitively expensive for most residents and most goods; so the primary method of transportation between San Jose and Manila was by inter-island ferry. These ferries provided passenger, cargo and vehicle service. San Jose was serviced by ferry 3 times weekly. All service was overnight (approximately 12-14 hours steaming time) with two trips going to and from Batangas City, approximately 3 hours south of Manila by bus, and one weekly trip going directly to and from Manila. Due to improvements on the provincial highway and the harbor at Abra de Ilog on the north end of Occidental Mindoro, it had recently become possible to drive from San

Jose to Abra de Ilog (approximately 8 hours) and then take a ferry from there to Batangas City. Although this did not appreciably reduce travel time, it did reduce cost because the ferry trip was much shorter.

Schools

Two elementary schools were located near Imbarasan. A K-3 school was located in *sitio* Bayombong which borders Imbarasan on the south. A K-6 school was located in the center of *barangay* Mapaya. Both of these schools were a significant (as much as 2-3 hour walk) from much of Himamara. The nearest public high schools were located in San Jose town and in Magsaysay town. A Catholic high school was also located in San Jose. Although it was possible for high school students to live in the area and commute to high school daily, it was very difficult. In practice, all current high school students lived in one of the two towns, either with relatives or as paying boarders. A couple of the most successful families in the area had purchased house lots and constructed houses in San Jose town to provide a place for their children to live while they pursued their education. In these cases, children usually attended elementary school in town since the town schools were perceived as having higher quality.

Markets and retail establishments

There were a several small retail establishments scattered throughout Imbarasan / Himamara and many more in the *barangay* of Mapaya, largely concentrated along the main roads. These *sari-sari* stores were generally run by women out of one room attached to their house and sold a wide assortment of goods including canned food, beverages, candy and other treats, sugar, coffee, kerosene, cigarettes and matches. In addition, they sometimes bought and sold small amounts of agricultural produce.

In addition to the *sari-sari* stores, there were three small rice mills located in Mapaya proper reasonably close to Imbarasan / Himamara. All of these small mills bought a limited amount of unmilled rice from local farmers and provided credit to farmers in return for a fixed amount of the rice harvested. In addition, they provided milling services for a small fee.

Although most residents frequented *sari-sari* stores for small, immediate purchases and some entered into limited credit arrangements and used the milling services of local rice millers, residents conducted the vast majority of their business dealings in San Jose town. San Jose was a fishing port and agricultural marketing center with an urban population of approximately 40,000 and had a small but reasonably well developed market for agricultural products. Several large rice mills and warehouses purchased rice, corn, mung beans and garlic. Vegetables, fruits and forest products were traded in the community market. There were also a number of moderate-sized retail establishments selling agricultural products and supplies, household goods, hardware, clothing, shoes, medicines, food, etc.

Other services

The current *barangay* captain had revitalized the barangay administration since I served in the Peace Corps in Imbarasan / Himamara in the late 1980's, and had built a community hall and basketball court near the main elementary school. A local basketball league and weekly dances were common forms of entertainment and social interaction in the dry season. A health center had been included as part of this new community hall. However, no residents that I interviewed reported having gone there for care. Medical care was typically obtained from the local traditional practitioner (*hilot*) or in San Jose town where there were several physicians and three hospitals (two private, one public). There was a small chapel in Mapaya proper that was visited by a Catholic priest from the San Jose municipal parish on an irregular basis for baptisms, weddings and funerals. A recent addition to the barangay was an office of PLAN International, an international non-government organization that had been active in the area. The office was staffed by NGO personnel from San Jose town on an irregular basis. PLAN's primary mission was to provide monetary support for children. However, it had also provided funds for a handful of area residents to replace thatch roofs by metal sheeting.

A large number of other services were available in San Jose town. These included municipal offices (police, civil clerk, municipal records), government agencies (agriculture, DENR, trade and industry, census, etc.), banks, hotels, and various entertainment establishments (cinemas, bars, restaurants).

Information availability

Another important factor in understanding the community environment was the availability of information. There were several sources of general information and information specific to agriculture that were important in the community. The most important sources of information were contacts with other farmers and with friends or relatives in San Jose. Additional agricultural information was provided by the ISFP technician. Although much of his time was devoted to completing the necessary paperwork to ensure continued farmer eligibility for the ISFP; he regularly met with farmers and provided information on DENR policies and activities. During my Peace Corps service, I was the ISFP technician assigned to the area and supervised the maintenance of a nursery and the distribution of seedlings to interested farmers. However, the nursery project was disbanded when I completed my term of service in 1990.

Other information was available via radio including a weekly program on agricultural topics conducted by the Department of Agriculture. Few residents actively read newspapers although some read the Tagalog language dailies from Manila when they were available. There was no local newspaper in San Jose. An mixed (English-Tagalog) monthly paper was published in Mamburao (the provincial capital) and included San Jose news but was seldom read in the study sites (I bought the only copy I ever saw anyone have).

Demographics

Population

According to the latest Philippine census figures (1995), the total population of *barangay* Mapaya was 6,181 individuals residing in 1,119 households (RP-NSO, 1995). Based on the survey I conducted as part of this research (1996), the population of the study site, *sitios* Imbarasan / Himamara, was 384 people distributed among 63 resident households.

Settlement pattern

The settlement pattern in Imbarasan / Himamara was characterized by scattered houses located on individual land holdings. In some cases, relatives with adjacent holdings built their houses on adjacent areas resulting in small clusters of two or three houses. In cases where residents had both lowland and upland parcels, the most common practice was to locate the house adjacent to the lowland parcel. However, the married children of some of the older residents had sited their houses on their upland parcels instead of on areas closer to the small parcels of rice growing lowlands they had inherited from their parents.

Ethno-linguistic background

All of the residents of Imbarasan / Himamara were members of lowland ethnic groups who either immigrated from somewhere else themselves or grew up in the area as children of the original migrants. The largest percentage of adult residents, defined as heads of household and their spouses (total 122), were from the island of Panay

(38%). The second largest group were those who grew up in the area or in nearby communities (31%) and the third largest group were either from elsewhere in Occidental Mindoro or were from the neighboring province of Oriental Mindoro (25%).

Linguistically, all residents surveyed spoke Tagalog, the lingua franca of Occidental Mindoro, as either a first (28%) or second (72%) language. However, the Hiligaynon language, spoken on Panay, was cited by 88% of residents as either their first (71%) or second (17%) language. As a consequence, it could be inferred that a significant percentage of residents who grew up locally and of those who are from elsewhere in Mindoro had their ethnic roots on Panay.

Household attributes

The average household size in the study area was 6 persons with a range from 1 to 13 members. Households were generally nuclear families consisting of two parents and their unmarried children. However, there were 9 single adult headed households (1 bachelor, 3 widowers and 5 widows). Two of these single adults, the bachelor and one of the widowers, resided alone. In the remaining seven cases, the household consisted of the single adult and one or more children.

Settlement history and changes over time

The earliest settlers arrived in the area in the late 1940's and early 1950's from Panay Island directly or from other parts of southern Occidental Mindoro where they had previously been employed in sugar cultivation. These earliest settlers reported that the area was forested until the start of commercial logging operations in the early 1950's. Although logging continued through the mid-1970's and scattered patches of high forest remained in inaccessible areas further into the mountains, Imbarasan and Himamara were completely logged by the middle of the 1960's. Migrants continued to arrive throughout the 1960's and 1970's with the peak number of arrivals (14) occurring in 1979. Since the mid 1980's, migration to the area had slowed considerably and only 14 adults (13%) reported arriving after 1990. The average years of residence in the area was 21 years with a range from 2 years to 52 years. Imbarasan was settled slightly earlier on average than Himamara (21.9 years ago vs 19.5 years ago) but this difference was not statistically significant ($t = 1.12$, $P(t) > 0.1$). Residents reported that the original land clearing concentrated on valley parcels. These reports were supported by the significant positive relationship (Pearson's $\rho = 0.26$, $P(\rho) < 0.05$) between the ownership of larger valley parcels (defined as greater than 2 ha) and the years of residence in the area. After the initial settlement of the prime valley areas, cultivation moved onto the hillside areas. For families with valley parcels, the typical pattern was to divide the valley land among their children. This practice left the next generation with small valley parcels and necessitated the inclusion of hillside areas. In addition, new migrants were forced to settle hillside and upland areas since very little if any valley land remained unclaimed.

The vast majority of households (92%) reported that they had at least informal tenure over their land. The remaining 8% of residents (5 households) were tenants.

Of those who report land use rights, 53% based their claims on the fact that they settled and improved previously unused land. An additional 33% had either inherited land outright or borrowing it from relatives (primarily parents). In spite of the legal prohibition on land sales, the remaining 14% of land holders reported that they purchased their holdings.

Resources

Claimed land

According to records obtained from the Department of Environmental and Natural Resources (DENR) office in San Jose, the two communities cover an area of approximately 340 hectares. Based on this value and the population values discussed earlier, the estimated population density was 1.1 persons/hectare. In the survey administered to residents during this study, residents asserted control over approximately 180 total hectares. Using this figure for land area gives a population density of 2.1 persons/hectare. In either case, this population density was very low when compared to lowland population densities in the Philippines and to population densities in other tropical upland areas such as Java, Indonesia.

There were several possible reasons for the wide discrepancy in land area and the resulting discrepancy in population density: 1. There were scattered patches of hillside, usually steeply sloping, land that was not claimed by any residents and was not being intensively managed. Taken together these parcels occupied a significant area. 2. The boundaries of the study communities were generally agreed upon but by no means completely fixed. In particular, the ISFP site area provided by the DENR included unknown amounts of *sitio* Tigue, located further up into the mountains and at present used only for scattered *kaingin* cultivation and the collection of forest products. 3. It was difficult for residents, and even for trained personnel, to accurately determine the size of sloping upland parcels.

Average reported land holdings were 2.9 hectares with a maximum of 9 ha and a minimum of 0.5 ha. Most residents (89%) had small parcels of valley land (average size 1.1 ha) and virtually all residents (97%) had upland areas (average total size 2.0 ha). Most individual upland parcels were small (average 0.8 ha) and were located on steep slopes (61% of total cultivated upland had reported slopes in excess of 30%). Land holdings in the two communities were relatively evenly distributed (Gini ratio = 0.35).

Local land classification

Residents described a well developed and consistent classification of land types. Land was generally classified by use or potential use. *Gubat* was the term used to classify all non-managed or extensively managed forest lands held either publicly or privately. Upland areas that had been cleared for annual crops were classified as *kaingin*. However, the land need not be cleared and planted to annuals at the time of the discussion to still be classified as *kaingin*. *Kaingin* areas were also characterized by cultivation without plowing. Upland areas that were plowed and planted to annual crops (but cannot be flooded) were classified as *bantod*. Lowland areas that could be flooded during rainy season were classified as *bukid.* The final type of land classification was sometimes used for parcels that were dominated by one specific crop or perennial species. This classification was formed by adding the "- *(h)an*" suffix to the species in question (e.g. *sagingan* -- banana orchard, *kamotehan* -- cassava field).

Unclaimed and extensively managed land

I observed considerable land scattered throughout the two *sitios* that was not specifically claimed by any of the local residents. In addition, there is considerable unclaimed land located the mountainous areas to the north and east of Himamara that were cultivated infrequently by *sitio* residents and were sparsely populated by members of the Hanunoo Mangyan ethnic group, the native inhabitants of this part of Mindoro. Unclaimed land within the communities is concentrated along streams and on steeper slopes. These unclaimed lands were a valuable source of forest products including two bamboo species, *kawayan tinik* (*Bambusa blumeana* Shult.) and *patong (Gigantochloa levis* (Blanco) Merr.), *buri* palm (*Corphya ulan* Lam.), and small timber that was used for fuel or for charcoal production. Additional sloping land was covered with *cogon* grass (*Imperata cylindrica*). This land was used for cultivation only as a last resort. The preferred management strategy was to harvest the *cogon* grass for roof thatch, either for home use or for sale in San Jose.

Unclaimed land further from the road and at higher elevations was used as a source of fuel wood and of wood for charcoal production. Collection activities took place almost exclusively during the dry season. Residents had also developed small *kaingin* fields in the higher elevation areas in the past but preferred not to at the time of this study, due to the regular presence of the NPA in the area and the risk of catching malaria, especially during rainy season.

Other resources

There were other resources available to local residents in addition to those mentioned above. As recently as 5-6 years ago, small fish and shellfish were abundant in local streams and were a common source of additional protein for households. However, residents reported that stream life is now virtually non-existent and only one household reported fishing as an activity. This decrease in stream life seemed to correspond to the increased application of molluscicide in rice paddies to control the golden apple snail, a serious rice pest. A few small animals could still be found in the area, and wild chickens and monitor lizards were hunted by residents on an occasional basis. Larger game was likely to still exist further into the mountains, but no resident mentioned hunting activities either in informal discussions or in the household survey.

Access to resources

Access to all of these community resources was generally first come, first serve; however, there was a strong ethic of taking only the amount that you could use (either personally or that you could process and get to market). In addition, since many of these natural products (e.g. *cogon*, *buri*) required drying in the field before transport, once you cut the grass or fronds, you owned it. If they were then taken by another, this was considered theft and was punishable as such. However, my key informants could think of no case where this type of theft had occurred and so were unable to provide me with information about how the situation was addressed.

In the case where the resource was on land claimed by another, but currently unused by that household, it was up to the interested harvester to identify and locate the land "owner" and obtain their permission before harvesting the product. In the case rapidly renewable products such as *cogon* or fruit, or if the harvester was a relative or friend, the owner usually did not charge a fee for use of the resource as long as he or she did not intend to use the resource themselves. However, the harvester typically paid the owner a mutually agreed upon price for the right to harvest more valuable, and more slowly renewable, products such as building timber, poles and bamboo.

Activities and Enterprises

Residents of Imbarasan and Himamara engaged in a number of different activities and enterprises, that, taken together, made up their household livelihood system. This section summarizes these various strategies including annual crop cultivation, perennial crop and tree cultivation, raising livestock, other on-farm activities and enterprises, and off-farm activities and enterprises.

Annual crops

The agricultural activities of most households in Imbarasan / Himamara were dominated by annual crop cultivation. Only 1 of the 63 households surveyed did not cultivate at least one annual species. In total, 22 different annual crops were cultivated in the area during 1995-1996 (Table A1.1). The most common crops were: maize (78%), *palay bukid* (75%), mung bean (38%) and cassava (33%). Garlic (21%) had become an increasingly important dry season cash crop in lowland rice areas while upland rice was an important crop for those without access to lowland fields and was cultivated by 16% of residents.

Cropping pattern

The land use pattern in the area was strongly influenced by the availability of *bukid* for rainy season rice cultivation (*palay bukid*) and the water availability on that parcel during dry season. For residents with lowland holdings (89% of all residents), flooded rice was planted as the main, rainy season, crop in nearly all *bukids*. The rice was seeded into seed beds in May, transplanted to fields in June/early July and harvested in late November or early December. The most common variety used in the area was IR42, a 120 day variety released by IRRI a number of years ago. Some farmers also planted IR64, a 90-100 day variety also from IRRI that was more glutinous than IR42. In addition, some farmers planted small fields with *malagkit* (sticky, highly glutenous rice). The typical local variety used matured in approximately 120 days.

Most *palay bukid* was cultivated using inputs of chemical fertilizers (85%) and pesticides (94%). The most common fertilizers used were urea (87%) and 14-14-14 (42%) . One household reported using 16-20-0. Average application rates were 74 kg/ha for nitrogen, 9 kg/ha for phosphorus and 17 kg/ha for potassium. Insecticides were used by all households that used chemical pest control. Other pesticides used were molluscicides (snail killer) (27%), herbicides (23%) and fungicides (20%). Nearly all households (91%) only applied chemicals when they observed pest damage.

According to residents, the use of *bukid* in dry season following the main rice crop was dependent on the level of available irrigation water and soil moisture. If the land could be irrigated to maintain flooded conditions, a second crop of rice was planted. Most of the time IR64 was used because of its shorter growing period. If the land could be irrigated to maintain a moderate level of soil moisture (particularly for the first part of the dry season) maize was planted. However, this second maize crop was being increasingly replaced by garlic, a higher risk crop that provided the potential for very high returns. If only residual moisture was available, mung bean was planted in lower fields or in fields that were likely to have higher residual moisture based on past farmer experience. If no irrigation water was available and the residual moisture level was perceived to be very low, the land was left fallow.

Upland areas were managed using several different strategies that depended on: 1) the presence or absence of *bukid*, 2) the quantity and quality of upland available, and 3) household preferences. In general, upland areas were managed using a *kaingin* system. *Kaingin* cultivation typically involved clearing a field of the existing vegetation (usually secondary forest), burning this vegetation on the field and planting crops by direct seeding (dibble planting). The land was typically cropped for one or two years, occasionally longer, and then left fallow. Depending on the type and amount of vegetative regrowth during the dry season, the land could be burned again between the first and second years of cultivation. .

Household circumstances and preferences strongly influenced this general *kaingin* strategy. For those households that had *bukid* in addition to uplands (84% of all households), their upland fields are generally managed as a supplement to their *palay bukid* cultivation activities. As a consequence, they usually planted crops that were potentially marketable (e.g. maize) or could be an emergency food source if the rice crop failed (e.g. maize, cassava, sweet potato). They usually did not plant upland rice (*palay kaingin*). They were also more likely to plant fruit trees in their *kaingin* areas as soon as possible. These households usually did not intensively manage their *kaingin* fields and only devoted time to them that was not needed for management of their *bukid* parcels. As a consequence of all of the above factors, their upland fields were generally small and fallow periods were generally long.

The second group of households had no *bukid* parcels. These households were much more likely to plant *palay kaingin* as their primary upland crop. They cited two reasons for this: 1) they needed the rice to eat and 2) they could obtain good rice yields through more intensive management (frequent weeding). This group was also likely to plant maize and/or cassava in their upland fields. In a few cases in Himamara where upland areas were generally larger and flatter and the soils were more fertile, households used a more intensive management strategy including cultivating the same area for as many as five years and converting some of the area to *bantod* (plowed upland). On the less fertile soils and more steeply sloping fields of Imbarasan, households were most likely to plant maize and cassava in their *kaingin* fields due in large part to the competitive ability of these crops vs weed species. Upland rice was also planted occasionally but, the level of management required to obtain reasonable yields was not believed to be justified by this group of households. Because they had only small parcels available, this group was most likely to be forced to cultivate parcels and reduce fallow periods in a manner that was likely to lead to significant soil degradation through soil loss via erosion and general soil nutrient mining by crops.

However, some members of this group had responded to these conditions by adding perennial components to the annual cultivation system. Common practices used included the retention of useful species (primarily *buri*) throughout the *kaingin* cycle and the planting of fruit and forest trees during or after the annual crop cultivation period . Tree planting in this manner could result in the transition of the area from shifting cultivation to tree plantation or fruit orchard. One household had used this strategy over the years to develop a system based entirely on banana cultivation. Fallow enrichment using nitrogen fixing trees (*ipil-ipil* — *Leucaena leucocephala* (Lam.) de Wit) was also being used by some residents.

In general, dry season and upland crops were cultivated using limited fertilizer and pesticide inputs. Garlic was the only crop where significant input use was reported (38% of households use fertilizers and 38% use pesticides). Only a small number of households reported using fertilizer in maize (10%) or mung bean (17%) cultivation. The use of pesticides, specifically insecticides, in these two crops was more common (50% of mung bean and 40% of maize).

A wide variety of vegetables were cultivated by nearly all resident households. Vegetables were typically cultivated in small plots near the residence and used for home consumption. Only 29% of households surveyed reported cultivating vegetables; however, I believe that the discrepancy between this value and my observations was due to that phrasing of the survey question which could have been interpreted as only pertaining to the major crops grown. Therefore, some households did not consider small numbers of vegetables to be an appropriate response. The survey responses generally reflected those cases in which households cultivated a larger amount of a specific vegetable (e.g. yard-long bean or tomatoes) with the goal of selling it. This was typically done during the dry season and the individual vegetable plants were often hand watered. There was a market for vegetables in San Jose town and one household in Imbarasan had become increasingly dependent on vegetable production for their livelihood. This family had intensified their vegetable production though the use of fertilizer and a variety of pesticides. Of the households that reported vegetable cultivation, 33% reported the use of small amounts of fertilizers (urea) and 50% of households reported the use of insecticides. Most (78%) households reported only applying insecticides when damage was observed.

Households that cultivated vegetables for home consumption were unlikely to use chemical inputs except for small amounts of insecticide to combat severe insect infestation.

Crop yields

Yields for the five major crops in Imbarasan / Himamara varied considerably between farms (Table 4.2). Overall, the yields for all crops except lowland rice were low. Yields for cassava were very low compared to other areas. One likely reason for this was that cassava was used as a crop of last resort in this area. Therefore, it was only harvested as needed and so reported yields only reflected household needs, not actual biological productivity.

Table 4.2. Annual crop yields in Imbarasan / Himamara

Crop	Number of households	Average yield (kg / ha)	Minimum yield (kg / ha)	Maximum yield (kg / ha)
Palay bukid	39	3,500	1,500	6,000
Palay kaingin	9	600	100	1,000
Maize	48	700	75	2,000
Cassava	17	1,750	200	15,000
Mung bean	20	525	200	2,500
Garlic	12	1,200	100	4,000

Use of crops

Annual crops were used both for subsistence and for sale. *Palay bukid* was used for home consumption by over 90% of households. Those households that did not cite it as being used for consumption, cited payment of debts as the use for their rice crop. Debts must be paid first before any of the rice can be retained. Debt repayment was cited by a total of 37% of all households as a use for *palay bukid* while an additional 32% of households reported selling it. Of the other major annual crops, *palay kaingin* (89%) and cassava (90%) were grown predominately for subsistence purposes. Maize was used both for sale (85%) and subsistence (40%). Mung bean was sold by all those who reported cultivating it although 29% reported retaining some for household consumption. Garlic was sold by 67% of cultivators while 50% of cultivating households reported keeping some of the crop for planting materials (42%) and home consumption (8%).

Livestock

Every household surveyed in Imbarasan and Himamara raised at least one species of animal. The most common small livestock were chickens (97% of households) and pigs (40%). Seventy percent of households owned at least one *kalabaw* (water buffalo). Cats and dogs were also present in most households. Other, less common, types of livestock included cattle (11%) and goats (10%). A small number of households also raised other fowl species (geese, ducks, turkeys and doves) (Table A1.2).

With respect to number of individual animals, chickens were again the most common species with an average of 10 birds per household; although there was wide variation between a minimum of 1 and a maximum of 60 birds. Of the households that raised pigs, 76% had only one animal and an additional 16% had two. Only one household indicated that they were raising a large number of pigs (10 animals). For buffalo, 59% of the households who owned an animal owned only 1 and an additional 32% owned two animals. The remaining four households owned 3 (1 household), 4 (1 household) and 5 (2 households) buffalo.

The primary uses for animals were consistent across the community. Chickens were used overwhelmingly (82%) for home consumption and occasionally sold (18%). In contrast, pigs were nearly always raised for sale (92%). Buffalo were raised exclusively as work animals. Of the less common species, cattle were raised exclusively for sale, goats for both household consumption and sale, and other fowl predominately for household consumption. Dogs and cats were raised primarily for use around the household as watchdogs and to catch rodents; although dogs were sometimes eaten, particularly on special occasions.

Perennials

Households in Imbarasan and Himamara also used a variety of perennial species. The majority of these were cultivated on lands held by the household; however, some were collected from unclaimed common lands either within the *sitios* or in the mountain areas to the north and east. Residents listed a total of 26 different perennial species (Table A1.3) including fruit trees, forest trees, multipurpose trees, bamboos, palms and grasses. The average number of species used per household was 5.75 with a range of between 2 and 10 species.

The most common fruit trees cited in the survey were mango (52%), banana (38%), cashew (32%) and jackfruit (24%). However, based on informal interviews and my observations, I believe that the survey results underestimated the presence of small numbers of fruit trees. This was especially true of bananas. Nearly every household had at least one clump of bananas growing near their residence. Based on the survey results, the minimum number of bananas cited by those who said that they grew them was 10. I infer, therefore, that people with smaller numbers of bananas or other native fruits were less likely to mention them in response to the survey. This was in direct contrast to higher value fruit trees (that usually are grown from purchased seedlings) such as mango and cashew where the presence of small numbers of trees (under 5) was regularly mentioned.

The use of forest trees in general was mentioned by 48% of all residents; however specific species were mentioned only by a few. The most common multipurpose tree species being used by residents was *ipil-ipil* (*Leuceana leucocephala* (Lam.) de Wit) (52%). Other species mentioned included melina (*Gmelina arborea*), *sampalok* (*Tamerindus indica* Linn.) and *kamatsili* (*Pithecellobium dulce* (Roxb.) Benth.). Other perennials regularly used by residents include *buri* palm (*Corphya ulan* Lam.) (92%), *cogon* grass (*Imperata cylindrica*) (48%) and at least two different species of bamboo: *kawayan tinik* (*Bambusa blumeana* Schult.) (84%) and *patong* (*Gigantochloa levis* (Blanco) Merr.) (11%).

Perennials used by the household came from the household land holdings, from unclaimed lands and occasionally from lands owned by a relative or friend. Surveyed households reported that all fruits were harvested on individual land holdings while *buri*, bamboos, forest trees and multi-purpose trees were harvested from both individual (often fallow *kaingin*) and unclaimed land holdings. An abandoned black pepper plantation in *sitio* Tigue (now covered by moderate sized *ipil-ipil* trees) was a common land source of wood for charcoal and fuel. All of the *cogon* grass harvested came from common lands scattered throughout the area, particularly on hilltops. These results were generally consistent with my personal observations and informal interview results. The major differences were that I observed fruits being occasionally harvested from common lands and, more commonly from the holdings of relatives or friends (harvested with their permission -- see section above). I was also told that a local market existed for building materials since very few trees suitable for use as building materials existed on unclaimed lands except for those lands high up in the mountains where access was difficult.

Even when they were located on individual land holdings, perennials were generally not managed intensively. Fruits were harvested; leaves, stems and fronds were cut; dead wood was collected for fuel; small trees were harvested for poles; and small and moderate sized trees were harvested for firewood and charcoal. However, all households undertook some perennial management activities. Nearly all households had deliberately planted trees near their home site. Useful tree species (primarily fruits) were also regularly planted in *kaingin* fields. While seed saved from fruits and natural wildlings provided the most common planting materials; some households had purchased tree seedlings, especially for higher value species like mango. Others had received them free from the DENR as part of agency extension efforts. And still others had set up small nurseries and raised their own. Planting of non-fruit species was less common; however, some households had started to plant gmelina seedlings around house lots and in *kaingin* areas. One household (example household IH 7) had planted the majority of their upland holdings to gmelina. Others households had begun actively scattering *ipil-ipil* seed in newly fallowed areas instead of relying completely on natural regeneration. One household was actively collecting, rooting and out-planting bamboo cuttings in order to create a large bamboo stand that could be managed for pole production.

There were other instances where perennial management was intensifying. Several households were managing banana groves for fruit production. One household (example household IH6) had developed a livelihood system based nearly exclusively on banana production. At the present time, no one was using inorganic fertilizers in banana cultivation; however, they were spending increasing amounts of time to keep the clumps pruned, to select one sucker per season and remove competitors and to reduce competition from other species by weeding. Some households were also intensifying their mango production. Several reported spraying their trees with sodium nitrate to promote flowering and using several different insecticides to insure good fruit set and good fruit quality. Only one household reported using inorganic fertilizers in mango cultivation.

The products from perennial species were used in the household itself and sold depending on the type of product and its availability. If only small numbers of fruits were harvested, these were usually consumed within the household. Some also entered the local sari-sari store market system. If larger amounts of fruits were harvested, they were taken to San Jose and sold. At present, the only fruit from the area sold in any significant quantity was bananas. Charcoal was seldom used for fuel in the area and instead was sold in San Jose or used in town by relatives. Wood was the major cooking fuel and so considerable amounts were used by each household. A few households reported selling wood as firewood in San Jose although making wood into charcoal before selling it was more common. Limited amounts of bamboos, *buri* and *cogon* were used by the household, larger amounts were transported to San Jose and sold. All three products, but particularly *cogon*, were often harvested on a contract basis.

Non-agricultural activities

Households also engaged in a variety of non-agricultural activities. The most common were: small scale trading (locally termed buy-and-sell); off-farm employment, primarily as day labor in agricultural activities; and semi-skilled and skilled jobs. The most common form of trading were the *sari-sari* stores mentioned earlier in the discussion on markets. Some household members (primarily women) also traded in consumer products, clothing and other goods.

Most households (71%) also depended on off-farm employment for a portion of their income (average 40% of total household income). Typically, one or more members of the household worked in agricultural activities on another person's land. Although labor sharing arrangements still existed where no money is exchanged; wage labor was becoming much more common, even between limited resource farmers. In many cases, this amounted to labor sharing (I pay you to help me today; you pay me the same wage to help you tomorrow) but economic incentives had taken the place of personal debts. In addition, there were some large landowners in the flatter parts of Mapaya nearer the ocean and in other flat areas nearer to Magsaysay and San Jose towns who employed nearly all of their agricultural labor. Limited and usually temporary off-farm employment also existed in the area; the most common form was temporary employment by the government for road construction and maintenance. Although none of the heads-of-household or their spouses was working full-time off farm; several households had children or relatives living and working in San Jose, elsewhere in the Philippines or abroad. A small number of residents (11%) also took part in other, sometimes highly specialized, non-agricultural activities. These included: hair cutting, manicures, tool sharpening, carpentry, welding and driving a tricycle (motorcycle with sidecar — a typical form of rural transportation).

Household finances

Obtain reliable estimates of household income and expenditures was difficult. However, I believe that the data I collected in this study provided a general idea of the types and relative amounts of income sources, expenditures and credit usage even if the exact amounts were somewhat unreliable.

Income

Most households reported multiple income sources (average of 2.3 sources per household) and reported a total average annual income of just under P24000 (the average exchange rate during 1996 was P29 = $1 US). Income sources, average amounts and percentage of total reported income are shown in Table 4.3.

As indicated in Table 4.3 the most common and important income sources reported by residents were the sale of agricultural products (75% of households, 71% of total income) and agricultural labor (67% of households, 43% of total income). Small numbers of households also derived income from the sale of fruits (5%),

Table 4.3. Income sources and amounts in Imbarasan / Himamara

Income source	Frequency (N = 63)	Average annual income (pesos) of those who reported the income source	Average percent of total income for those reporting this income source
Crops	47 (75%)	20,700	71%
Fruits	3 (5%)	16,000	38%
Animals	6 (10%)	5,400	21%
Forest products	6 (10%)	13,000	44%
Agricultural labor	42 (67%)	6,000	43%
Self-employment	7 (11%)	16,000	55%
Off-farm non-ag	1 (2%)	6,000	44%

animals (10%), and forest products (10%) and from self-employment (11%). However these less common income sources made significant contributions to the income of specific households (average 21%-55%).

Expenses

Households cited an average of 3.5 different major expenses and a total average annual expenditure of P35000. The different types of expenses and their relative importance are summarized in Table 4.4. Expenses for food (89%) were the most commonly cited expenses; however no household reported purchasing rice (the staple food grain). Other common expenses were land preparation (89%) and household supplies (87%). Expressed as a percentage of the total expenses, food (56%), agriculture (26%) and schooling for children (20%) were the most important.

Table 4.4. Major expenses and amounts in Imbarasan / Himamara

Expense	Frequency (N=63)	Average annual expense of those who reported the income source (pesos)	Average percentage of total expenses for those with the expense
Food (not rice)	56 (89%)	18,000	56%
Household needs	55 (87%)	6,500	16%
Agricultural supplies (including labor)	56 (89%)	9,000	26%
School	23 (37%)	12,000	20%
Medical	16 (25%)	1,700	6%
Other	3 (5%)	1,200	6%

Net

The uncertainty and potential unreliability of the exact numbers provided by respondents for income and expenditures were readily apparent in the calculation of net household income. If the numbers were assumed to be exact, 48 households (76%) reported negative net annual incomes ranging to a low of P111,800. Two households reported zero net income and the remaining 13 households (21%) reported positive net incomes with a maximum of P84,000. This calculation suggested that most households were not financially self-sufficient and were dependent on other sources of cash.

However, as mentioned above, I believed that there was a significant degree of uncertainty in both the amounts of income and expenditures. When I assigned what I believed to be a reasonable degree of uncertainty to the data (P1000 per month or P12000 per year either way for both total income and total expenses), 48 of the 63 households (76%) had net incomes not significantly different from zero, 12 (19%) had net negative incomes and 3 (5%) had net positive incomes. These calculations more closely matched my personal observations and informal interview responses that indicated that only a small percentage of residents were in financial trouble. Most were breaking about even.

Credit

One possible source of cash to make up for income deficits was credit; however, I did not conclude that this was the case in Imbarasan / Himamara. Although the use of credit was common in the area, 46 households (73%) reported borrowing money during the past year; all of the reported borrowing was short term (a crop season or a few months). Money was typically borrowed from local informal lenders (83%) and rice millers (10%) and was most commonly used for agricultural production expenses (82%) although it was sometimes used for school expenses (9%) and rarely used for household (4%) and food expenses (4%). Those who borrowed money borrowed an average of P13,000.

Typical interest rates were very high. The common credit system for *palay bukid* production was a payment at harvest of 5 or 6 sacks (50 kg) of unmilled rice for each P1000 borrowed at planting. Based on the prevailing prices at the time of the study, this resulted in an annual interest rate equivalent of between 225% and 400%. However, this form of credit required no collateral. Other credit sources did require some sort of collateral, usually land. These credit sources, located primarily in San Jose, still charged very high interest rates (usually 5% per month which is equivalent to 80% per year). In theory, credit was available to small producers at reduced interest rates through the Land Bank (government of the Philippines); however, in practice, local residents had been unable to access this credit source.

Other issues

Two other issues have had and continued to have a significant impact on the household livelihood systems in Imbarasan and Himamara. These were the off and on presence of the New People's Army (NPA -- the military arm of the Communist Party of the Philippines) and the continuing incidence of malaria. The NPA had been a presence in the area to a greater or lesser extent since the mid 1980's. None of my cooperators reported that any active fighting had occurred over that time between the

NPA and government troops; however, the presence of the armed insurgency and the perception that there is the potential for violence to break out was cited by residents as a primary cause of the very low immigration rate over the past several years. This low immigration occurred in spite of continued net immigration to the province of Occidental Mindoro and in spite of the ample available land located in the area, especially closer to the mountains (*sitio* Tigue) . It was no coincidence that these mountain areas are where the NPA had been most active.

Another factor that was cited as a reason for the relative halt to immigration was malaria. As one went further into the mountains in Occidental Mindoro, there was more moisture available and a shorter dry season. Although these factors increased the agricultural options available to potential settlers, they also increased the mosquito population and were related to the greater incidence of malaria. Troubles with worker illness and with the NPA were both cited as reasons for the closure of a proposed black pepper cultivation project in *sitio* Tigue in the late 1980's. Several residents also stated that they preferred not to live or work in Tigue during the rainy season because of the malaria risk.

Example households

The previous section provided an overall description of the community of Imbarasan and Himamara. In this section, I provide brief descriptions of the eight example households that used as the basis for my analysis of livelihood system sustainability. More detailed household descriptions are provided in Appendix 1.

The descriptions of these example households were grounded in one specific household; however, they were not exact descriptions of these households. Six of the example households represented the major types of management systems used in the area. The other two example households, IH7 and IH8 represented unique and interesting circumstances.

Development of some of these example household descriptions was somewhat complicated. After my first few visits to Imbarasan / Himamara, I had started to develop detailed descriptions of the households of several key informants. Unfortunately, my interviewing activities were cut short by the arrival of the NPA in July, leaving these descriptions incomplete. In two cases, example households IH2 and IH5, I was able to match the formal survey to the key informant which allowed me to combine data from the two sources to develop a more complete description. In three other cases, IH1, IH4 and IH6, I was only able to identify a group of households with similar resources and a similar management strategy to that of my key informant. In these cases, I used the average or most common of all relevant survey results as appropriate to fill in gaps in the household descriptions. In one case, IH3, I had collected only a small amount of information from key informants with that type of management system and so based the description on information provided by the survey that I believe best represented the group. The final two cases, IH7 and IH8, represented unique situations. The descriptions of these households were limited to the interview data that I collected prior to July, 1996.

Household IH1

The first example household represented the most common class of household livelihood systems in the community (25% of all households). These households were generally characterized by access to both *bukid* and upland areas and by larger total land holding size (3 ha or more). They also had some access to irrigation water. Most of these households were located in the valleys of *sitio* Himamara. They were generally headed by middle-aged couples who migrated to the area at least 20 years ago. Their children, most of whom were born in the area, were in their teens and twenties. Their livelihood system was dominated by the cultivation of *palay bukid* in rainy season followed by the cultivation of a mixture of *palay bukid,* garlic, maize and mung bean in dry season depending on the level of irrigation available. They also cultivated backyard vegetables and small numbers of fruit trees on house lots and upland areas adjacent to their lowland fields.

Household IH2

The second example household represented another common group of households (14%) in the area. These households, generally headed by people in their late-20's or early 30's with small children had small amounts of *bukid* inherited or loaned from their parents who were the early settlers in the area. These *bukid* parcels had some access to irrigation water in dry season. They had also claimed access to upland parcels. Several families had moved off their holdings to be nearer to schools for their children. Although their children attended public schools, school expenses in the form of clothes, books, etc. were still a significant drain on limited budgets. Their management systems were similar to the previous example household group, but this group was more constrained by available land and often labor resources because they had small children. In addition, their upland areas were generally more marginal than those held by the older residents and were often located some distance from *bukid* fields.

Household IH3

Example household IH3 represented the third major class of households in the study communities (25%). Households in this group were characterized by having holdings consisting of both upland and *bukid* parcels as in the first two model groups. However, this third group did not have access to dry season irrigation. Although there was some within-group variation in the size of land holdings, holding size did not seem to be an appropriate criteria by which to further divide the group. Only two households reported large land holdings (6 and 8 hectares respectively) but even though they reported use rights to these large tracts of land, they only provided management information for a small segment of their holdings. This group was dominated by residents of sitio Imbarasan but was not dominated by a particular age group or family type. The typical management system for these households consisted of a main, rainy season rice crop in their *bukid* fields followed by maize or mung bean depending on late season rainfall and corresponding moisture availability. These lowland crops were supplemented by upland annuals, primarily cassava, and by small numbers of perennial species.

Household IH4

Example household IH4 represented the fourth group of households in Imbarasan / Himamara. This group was smaller (6%) that the previous three groups and represented a more specialized management system that placed a much greater emphasis on the cultivation of vegetables for sale in San Jose. Households in this group generally had access to both *bukid* and upland parcels and have access to dry season irrigation water. However, their holdings were generally smaller than average. The members of this group were older on average and had smaller families since many of their children had married and left their parents' household.

Household IH5

Example household IH5 represented another of the major groups of households in Imbarasan/Himamara (6% of all households). This group was made up of the most resource-poor households in the community. They had relatively small holdings of often steeply sloping uplands. They were young families and, as a group, were mainly dependent on the cultivation of annual crops using the *kaingin* system. Some households in this group also possessed small areas of *bantod* that were typically planted to *palay kaingin*.

Household IH6

Household IH6 represented the last group of households in Imbarasan / Himamara. This group of households (14% of all households) had only upland holdings like the previous group. However, this group was made up of older residents with generally larger land holdings who had developed systems that were increasingly dependent on the cultivation of perennial crops, particularly bananas and bamboo.

Household IH7 (special case)

Example household IH7 represented a unique management system in the area. I included it in this analysis because it appeared to incorporated many of the factors that had been discussed in the literature regarding how sustainable land management systems might be developed in Philippine upland areas. This household, through a combination of circumstances, had been able to convert nearly all of their upland holdings into a timber plantation (*Gmelina arborea*) combined with other perennial crops.

The heads of this household were also one of the few couples who talked repeatedly about being able to support themselves in their old age and about leaving something for their children. As a consequence, they were putting a heavy emphasis on gmelina. They believed that this provided the best alternative given the type of land they had available. The husband had gotten a job managing a tree plantation in an adjacent *sitio*. This guaranteed income had allowed them to go ahead with their plans to shift to a perennial dominated system since it assured them a source of income to meet family expenses for the 5-7 years between tree planting and tree harvest. They indicated that surviving until the trees were producing income was the primary constraint to resident adoption of any tree-based management system. Their future plans were to continue to plant more trees on their upland parcel and they eventually wanted to have the entire area planted to trees.

This emphasis on melina instead of banana, mango or bamboo was somewhat of a gamble given current conditions. At the time of the study, the processing and marketing facilities for melina did not exist in San Jose. However, they were betting that the recent development of larger tree plantations in the San Jose area, including the one that they were managing, would lead to the development of a processing and marketing infrastructure for this timber. They would then be able to make use of these structures to process and market their trees.

Household IH8 (special case)

The final example household (IH8) represented another unique set of circumstances. While the previous special case illustrated one possible direction for upland management in this area based on increasing ties to markets outside the immediate community, this household illustrated the opposite case of very strong autonomy. The household consisted of an older man, a bachelor, who was one of the early settlers in the area. He reported that he has cultivated maize in Himamara using a *kaingin* strategy for over 30 years. He had few ties to the outside world and his management system provided an example of a long-running, low input / low output system.

Site #2: Halang, Bayugo, Jalajala, Rizal

Community level

The second study site consisted of a single upland community named *sitio* Halang, in *barangay* Bayugo in the municipality of Jalajala, Rizal. As mentioned in the previous chapter, this location was chosen in part to provide a contrasting set of conditions to those in Imbarasan / Himamara and in part to provide the opportunity to help SEARCA, my principal Philippine collaborator, obtain additional information about an area where they had two ongoing projects (in cooperation with the University of Queensland (UQ)). The SEARCA presence in the area, specifically the presence of a full-time field technician, eased the community entry process for me at this site. In addition, I was able to take advantage of a considerable amount of information from research that had been conducted in Halang.

The description that follows was primarily based on interviews that I conducted with local residents, my personal observations during multiple visits to the area throughout 1996, and the results of a survey of sitio residents that I prepared and had administered to a saturation sample of local residents in September, 1997. This information was supplemented by information from two other sources: The report from a Participatory Rapid Rural Appraisal (PRRA) activity conducted in the area by SEARCA staff during April, 1994 (Vega et al., 1994); and a report on the preliminary results of a formal survey of sitio residents conducted in May, 1994 by M. S.C. Tirol, a UPLB professor and doctoral student at the University of Queensland (UQ), and three other members of the SEARCA-UQ project staff (Garcia et al., 1995).

Physical environment

Sitio Halang consisted of approximately 250 hectares located on the sloping uplands of the Jalajala peninsula between the coastal lowlands of Laguna de Bay and the Pagkalinawan River that roughly bisects the peninsula (Figure 4.4). The area was located approximately 3 km south of Jalajala town and about 80 km southeast of Manila (Vega et al., 1994).

Terrain

Elevation ranged from near sea level to about 300 m and nearly all the land was sloping, 31% percent of agricultural plots had reported slopes of over 30 percent. There was a small amount of flat, valley bottom land located in the southeastern corner of the sitio and small patches of flat land on the ridge top where most dwellings are located. The underlying geology of the area consisted of volcanic materials overlain by newer, limestone and sandstone sediments of marine origin.

Climate

Halang received an average of 2200 mm/year of rainfall, most of it concentrated in the months between June and November (Figure 4.5) . However, since the figure plotted the average rainfall data, it masked the regular occurrence of a mid-season drought from late-July to early September. Even in these average

Figure 4.4. Location of Halang

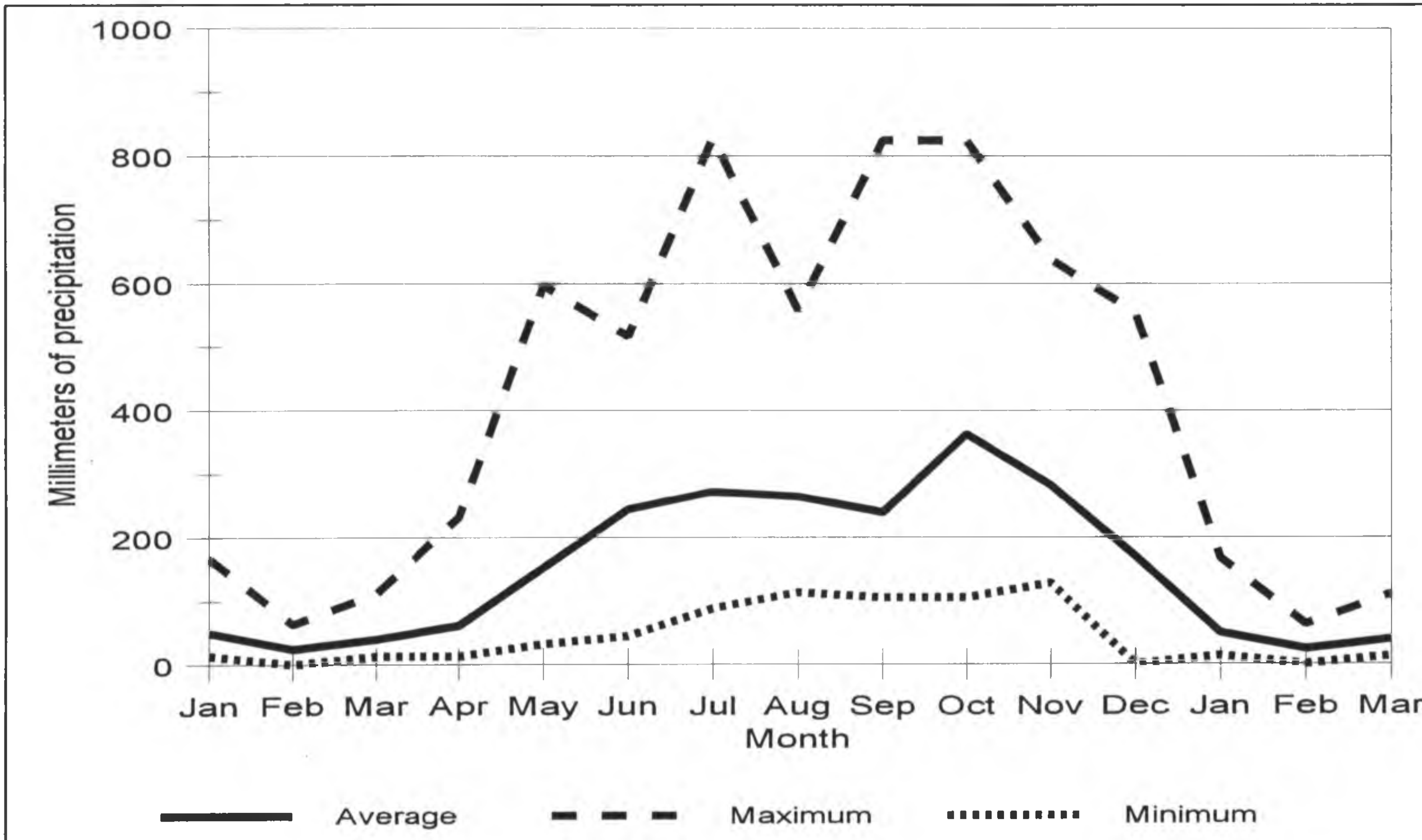


Figure 4.5. Rainfall pattern in Jalajala, Rizal

numbers, the strong effect of late season typhoons was apparent in the October, November and December values. Rosing, the last major typhoon to hit the area occurred in 1995 and caused significant damage to both agricultural crops and property.

Soils

Soils in the area were derived from the sedimentary parent materials. They were very shallow (often less than 30 cm), and were generally deficient in potassium. However, they did, in general, have sufficient levels of other mineral nutrients including P, Ca and Mg. Most soils, with the exception of small hilltop areas were of moderate to low acidity and had moderate to low levels of organic matter (Table 4.5). Residents identified the lack of soil depth and the tendency of these soils to display vertic (shrink-swell) properties (very sticky when wet, very hard with large cracks when dry) as the most significant constraints to management at the present time. All residents interviewed indicated that the native soil fertility was generally low and older residents had observed a noticeable decline in soil fertility over the past 20-30 years.

Land status / classification

The land that made up sitio Halang was originally part of three separate large land holdings (ranches) that had come under the jurisdiction of the Department of Agrarian Reform (DAR). Under existing land reform policies, residents were eligible to receive tenure to their parcels of agricultural land as long as they could show that

Table 4.5. Soils in Halang

Location	pH	% OM Walkley-Black	P (ppm) Bray 2	K (me/100g) NH4OAc	Ca (me/100g) NH4OAc	Mg (me/100g) NH4OAc
Hillside cropped n = 27	5.7 (5.0-6.2)	2.29 (1.24-3.52)	10.4 (1.8-34.4)	1.57 (0.51-3.48)	19.4 (13.5-22.9)	7.05 (4.11-9.21)
Riverside n = 3	5.5 (5.4-5.6)	2.60 (2.33-2.88)	25.4 (18.5-38.6)	1.89 (1.47-2.52)	15.8 (14.9-16.9)	5.05 (4.64-5.46)
Hillside perennial n = 3	6.0 (5.7-6.2)	3.27 (3.17-3.45)	11.6 (6.32-20.3)	3.03 (1.06-4.93)	17.0 (14.9-19.9)	6.20 (4.81-8.4)
Hilltop n = 1	4.6	2.38	3.51	1.08	17.0	4.11

they have resided in the area and have improved the land. Residents could receive up to 3 ha of land per couple with an additional 3 ha for each adult child. Assuming they meet the requirements, residents would receive a Certificate of Land Ownership Agreement (CLOA). In order to covert this CLOA to a true title, they would be required make regular payments on the land over the next 30 years to the Land Bank (Philippine government). The land must remain in agriculture for this payment period. According to the DAR technician assigned to the area, repayment rates could be adjusted for low productivity due to severe weather or other factors.

At the time of this research, holdings in the northern section of the *sitio* had been surveyed and residents had received their CLOA's. The process was ongoing in the middle section of the *sitio* but no problems were expected according the local DAR staff member assigned to the area. The situation in the southern part of the *sitio* was contested. The land had recently been sold by the original owners to a large land development corporation. During this sale process, the original owners produced a document indicating that the land zoning status had been changed from agricultural to residential in the early 1970's. They then argued that, since the land was rezoned in the 1970's, it was "idle residential" land, not agricultural and was therefore not subject to agrarian reform legislation. The DAR had taken the new owners to court in an attempt to force them to release the land for agrarian reform and the case was still ongoing. If the case is decided in favor of the government, the land reform process will proceed on this parcel. If it is decided in favor of the land development corporation, residents of that part of the community will lose any legal claims to their land.

Governance

Halang was one of four *sitios* that make up *barangay* Bayugo. As in Mindoro, *barangay* governance was dominated by residents of the lowland *sitios*; however, one resident of Halang was a member of the barangay council. The relative political marginalization of Halang was illustrated by two ongoing issues, the continued lack of improvements to the road that ran through the *sitio* and the lack of progress on a deep well to provide *sitio* residents with a reliable and safe source of drinking water.

Infrastructure and services

The livelihood of *sitio* residents was strongly influenced by the types and locations of available infrastructure and services including roads and transportation, utilities (electricity, water, sanitation), schools, medical care and markets for agricultural products.

<u>Roads and transportation</u>

A slightly improved dirt road ran from the lakeshore at *sitio* Kambingan up through the *sitio* and ultimately ended at a newly constructed radio-telephone relay tower located on the highest point of the *sitio*. During construction of the tower in late 1995, the road was slightly improved. At the time of the study (1996) the road was passable to two wheel drive vehicles with good ground clearance during dry season and much of it was passable to four-wheel drive vehicles year round except for during and immediately after large rain storms. The coastal road through Bayugo, north to Jalajala proper and on to Manila was paved in 1992 as part of the Integrated Jalajala Rural Development Project, a joint project of the Department of Agrarian Reform (DAR) and the Japanese International Cooperation Agency (JICA). The lack of an improved road into the *sitio* itself was cited as one of the major problems with living in Halang by 33% of *sitio* residents

Virtually all houses in the sitio were located within 3 km of the paved highway, although access from the northern part of the sitio involved taking a shorter but much steeper trail down to *sitio* Biga (north of Kambingan) or the much longer but better maintained road to the southern end of the *sitio*. There was regular *jeepney* service along the highway (at least 10 trips/day each way) to Jalajala and on to Tanay (another 15 km), the nearest moderate sized town. From Tanay, both buses and *jeepney*s offered service to Manila. Total travel time to Manila via public transportation was approximately 3-4 hours, depending on the waiting time and the traffic. The total cost of the trip was P40. One *sitio* resident owned a passenger *jeepney* (purchased with funds he made working in the Middle East) and used it to transport agricultural produce and occasionally people to Tanay and Manila. If a vehicle was available, one could be in Manila in under 2 hours. In addition, cattle and taro buyers regularly brought their own vehicles into the *sitio* to collect the cattle and taro that they had purchased and ship them on to Manila for sale.

Utilities

With the exception of one household, sitio residents did not have electricity. However, the major problem cited by residents was the lack of water in the area. When the area was initially settled, there was a perennial spring in the eastern part of the *sitio* near the river that provided a source of drinking water. In addition the river could also be used. However, as the area became increasingly developed, the spring had dried up for much of the year and the river water had become unsafe to drink. Therefore, all households obtained their drinking water from wells located in the coastal plain in Bayugo and hauled it up to their houses in Halang. In dry season, all their water requirements must be hauled in. In rainy season, most households collected rainwater off of their metal house roofs into large barrels (surplus oil drums). The richest household in the area (example household H8) had constructed a cement tank for storing rainwater runoff; however, their house was destroyed in the 1995 typhoon and so the tank was no longer usable. However, residents still obtained their drinking water from Bayugo, even in rainy season. Residents estimated that obtaining water occupied one household member and work animal (buffalo, horse or cow) for at least 2 hours daily. Given this situation, it was not surprising that all 42 households mentioned water availability as the first or second major problem associated with life in Halang.

As was to be expected given the water supply situation discussed above, sanitation facilities were either non-existent or consisted of pit latrines covered by a roof of native materials and surrounded by makeshift walls to give the user some privacy.

Sitio residents had been told that the *barangay* had funds available from the recently completed JICA project and that these funds could be used to drill a deep well in the sitio and equip it with a windmill driven pump to provide a local source of drinking water. Residents had already selected a potential well location based on a combination of the recommendation of the project geologist and the recommendation of a local dowser (water witch). However, during my time in the area, residents reported no progress on this project in spite of repeated discussions with *barangay* and DAR officials.

Schools

Since many of the sitio residents had children of school age, access to schooling was important. A public elementary school and high school were both located in Bayugo and were the schools attended by most sitio children. A few students also attended the Catholic high school in Jalajala proper. A small, provincial college was located in Tanay and at least two young adults were enrolled there in associates degree programs.

Medical facilities

Residents relied on traditional practitioners for basic medical care, although there was neither a *hilot* (local healer) nor a midwife residing in Halang. The nearest formal medical facilities were a *barangay* clinic in Bayugo and larger clinics in

Jalajala. For treatment of more severe conditions, residents consulted physicians in Pililla, where the provincial hospital was located, Tanay, or in the eastern suburbs of Manila (Pasig, Cainta).

Retail establishments and markets

There were three small *sari-sari* stores located in Halang itself. As in Imbarasan / Himamara, these *sari-sari* stores typically sold beer and soft drinks, cigarettes, canned goods, candy and sweets, kerosene and a variety of other goods including occasionally selling agricultural produce. Two larger sari-sari stores were located on the highway in Bayugo where the road and secondary trails from the sitio met the highway. A few larger retail establishments were located in Jajajala proper but most residents did their marketing, both sales and purchases, in the larger market and with larger suppliers in Tanay. The markets for both cattle and taro, the two main items sold for cash in the area, were dominated by Manila-based traders who came to the *sitio* to collect their purchases.

Information availability

In Halang, information on agriculture and animal care was often lacking. As mentioned earlier, the area was under the jurisdiction of the DAR. As a consequence, a DAR field technician was assigned to the area. Unfortunately, the DAR technician's expertise was in the area of community development and community organization, he had no background in agriculture. This was not an atypical problem in agrarian reform areas, particularly the uplands, since the DAR had been perennially short of staff trained in agriculture and had concentrated their best staff in lowland, rice growing area since these had been named the priority areas for land reform. Although I worked in the area for nearly one year, I never heard mention of any contact with staff from either the Department of Agriculture (DA) or the DENR. Information on taro cultivation and cattle raising were provided by taro and cattle marketers and by retail suppliers of products (e g fertilizers, pesticides, cattle medicines). A DA veterinarian had made regular visits to the area several years ago, but he left the local DA office and was never replaced.

The ongoing SEARCA / UQ projects in the area had provided information on potential new and improved agricultural management practices to the community as a whole and more specifically to a small group of cooperating farmers. However, some residents that I talked with expressed concern that the objectives of the project were significantly different from local management objectives and did not take local knowledge and experience into account. Therefore, some residents were skeptical about the potential utility of project findings.

Demographics

Population

The PRRA (Vega et al., 1994) conducted in 1994 identified 46 households and a total population of around 240 persons. A formal survey conducted later that year identified and surveyed 45 households and recorded a total population of 240 (Garcia et al., 1995). The survey conducted in 1997 as part of this research identified

42 households and a total population of 194 persons. I believe that the differences in these numbers were primarily because the 1994 research included five households that are located on the border between *sitio* Halang and the neighboring lowland *sitio* of Kambingan. I did not include these households.

Settlement pattern

The settlement pattern in Halang consisted of houses concentrated along the main road that ran along the ridge roughly bisecting the southern and central parts of the area. Residents usually had one or more fields adjacent to their house and some had one or more fields located some distance away in the more steeply sloping northern parts of the *sitio*. Others asserted claims to lands in other parts of the *sitio* but were not using those lands for agriculture largely because of access difficulties.

Ethno-linguistic background

Nearly all *sitio* residents were related either by blood or marriage to one of six family groups that originally migrated to the area from Calaca, Batangas. Batangas is one of the major Tagalog speaking provinces in the Philippines and all but four adult residents (all married to locals) were native Tagalog speakers.

Household attributes

As mentioned above, the survey I commissioned and supervised in the area identified 42 households. The average household size was 4.6 persons. Three households had only one member: one bachelor, one widow and one widower. The largest households had 10 and 11 members respectively. There were a total of six single adult headed households in the community, the three single person households and two more widows and one widower who lived with one or more of their children. The average age of the head-of-household was 39.5 years and ranged from 19 to 74.

Settlement history and changes over time

The first of the current *sitio* residents arrived in Halang in the late 1960's although one survey respondent who grew up on the lakeshore in Bayugo reported farming in the area as early as 1961. Over seventy percent of adult residents (defined as heads-of-household and their spouses, total = 78) had arrived in the area by 1977. According to the oldest living resident of the area, when he arrived in 1969 the lower hills of the *sitio* were covered with *cogon* (*Imperata cylindrica* (L.) Gaert.) and talahib (*Saccharum spontaneum* L.) grasses. Molave (*Vitex parviflora* Jus.) trees, the original vegetation, were still around in gullies and on higher slopes. However, all of the commercial grade molave had been harvested long before. In those early years, charcoal made out of these residual patches of molave forest provided the major source of income to help them establish their farms. It appeared that the molave was harvested quickly since reports from other older residents who arrived only a few years later (early 1970's) indicated that all but very small patches of residual forest were gone by that time. One of these later arrivals said, somewhat jokingly, that you had to be careful on trails when they first arrived, otherwise you would be run down by someone carrying a load of charcoal out of the area and down to the lakeshore to sell.

Even before the migrants from Batangas settled the area, it had been used sparingly by lakeshore residents for pasture, charcoal making, and occasional shifting cultivation fields. Although the *cogon* dominated land was initially very difficult to clear for annual crops, the soil was extremely fertile. Residents reported native rice and maize varieties growing nearly 2 meters tall in those early years. The eradication of *cogon* and *talahib* through a combination of burning and plowing, led to the establishment of a shrub-based natural fallow system dominated by *aroma* (*Acacia farnesiana*). Since they came from Batangas, the residents were aware of the potential for cattle raising. As a consequence, residents started managing the holdings, including fallows, by deliberately planting both napier grass (*Pennisetum purpureum* Schm.) and *ipil-ipil* (*Leuceana leucocephala* (Lam.) de Wit), primarily as cattle fodder although they had established napier hedgerows on some steeply sloping hillsides.

A management system dominated by rice and maize and including peanut as a legume was the primary system used in the area for a number of years. This system also included scattered fruit tree plantings and livestock raising. Residents had tried other annual crops including garlic and ginger but the major change in the system was the introduction of dryland taro in the early 1980's. Since that time, it had become a major component of most household management systems and was a major source of cash income.

Resources

Land

Land was the primary resource available to all agricultural producers. In Halang, all but two resident households claim use rights to land. The total amount of land claimed was 115 hectares. For those who had land (40 households), average land holdings were 2.9 ha but ranged from 0.25 ha to 9 ha. All of the households that owned land have upland areas. Six households also control small patches of lowland (0.25-0.5 ha). Two of these patches had access to irrigation. The other four did not. This information differed only slightly from that collected in the 1994 survey which identified 45 households with a total of 127 ha of land for an average of 2.8 ha per household.

Unclaimed land

The total land area of Halang was approximately 250 ha. Residents only asserted claims over 115 of these hectares. This suggested that there was a considerable amount of unclaimed land. There were several possible reasons for this discrepancy between total land available and land claimed: 1. Much of the unclaimed area in the northeastern part of the *sitio*, had very steep slopes and so was very difficult to cultivate. In addition, *kaingin* fields in this part of the sitio were a considerable distance from the existing roads and trails over rough terrain making access difficult. I observed that a significant portion of this area was still covered with second-growth and scrub forest (dominated by *aroma* and *ipil-ipil*). 2. Even though residents may have had informal claims on holdings in other parts of the *sitio*, some were probably reluctant to press those claims given the DAR limit of 3 ha on holding size. Only 13 of 40 farmers asserted claims to more than the government maximum of 3 ha of land. 3. One way residents had gotten around the 3 ha maximum was to officially title land in the names of their adult children, whether or not they were living or had any intention of living in the area. Therefore some claimed parcels may have been missed by the survey since their "owners" no longer resided in the sitio. 4. One of the largest land holders in the area was not interviewed during the formal survey. He had several children living elsewhere (Tanay, Manila) so only sporadically resides in the area. In an informal interview, he asserted a claim to a total of 15 ha of land.

Whether they used parcels on which they have some claim or not, most resident households make use of the products of these open lands, particularly small timber (*aroma* and *ipil-ipil*) which are used for charcoal production.

Land use classification

The land use classification system used by Halang residents was somewhat different than the classification system used in Imbarasan / Himamara. Halang residents made the same distinction as Imbarasan / Himamara residents between land planted with a dibble (*kaingin*) and plowed land (*bukid*). However, the term *bukid* was used to cover a much wider group of lands than in Imbarasan / Himamara. In Halang, any land that was managed by plowing was classified as *bukid*, whether or not it could potentially be flooded. As was the case in Imbarasan / Himamara, secondary forest fallow areas were classified as *gubat*, while areas dominated by one species (either perennial or annual) were referred to using the word formed by applying the *-(h)an* suffix to the dominant species (e.g. *sagingan* -- banana orchard, *maisan* -- corn field).

Activities and Enterprises

Most of the household livelihood systems in Halang were dominated by a relatively small number of components including annual crop cultivation, livestock, cultivation of some fruit trees, and charcoal production. Off-farm labor was also important for some households.

Annual crops

Annual crops were a livelihood system component for 36 of the 42 area households. However, households only reported cultivating a total of 8 different crop species (Table A1.1). The average number of species cultivated per household was 3.3. The primary annual crops were taro (92% of households with annual crops), maize (89%), peanut (75%) and *palay kaingin* (64%). Only two households (6%) grew *palay bukid*, and two households (6%) each reported cultivating cassava, *ubi* (purple yam) and unspecified vegetables. One household reported growing tobacco. Taro was used exclusively for sale and peanut nearly exclusively (88%). The remaining peanut was used for home consumption or saved for seed. Most households (47%) used maize for both home consumption and sale. An additional

41% of households used all their maize for home consumption while the remainder (12%) sold all of theirs. Rice (both *palay kaingin* and *palay bukid*) was used exclusively for home consumption as were the other minor crops although some vegetables were occasionally sold.

In order to address the declining soil fertility discussed in a previous section, most area residents cultivated their major annual crops using significant inputs of chemical fertilizer (91% of taro, 88% of maize, 97% of rice). The most common fertilizer used on all three crops was ammonium sulfate (21-0-0-24S). Urea (46-0-0) was also occasionally used. The 1994 survey found the following average fertilizer application rates: taro, 93 kg/ha of urea or 327 kg/ha of ammonium sulfate; maize 41 kg/ha urea or 80 kg/ha ammonium sulfate; and rice, 49 kg/ha of urea or 89 kg/ha of ammonium sulfate (Garcia et al 1995, p. 36-38). Based on the small number in my study who provided fertilization rate information, it appeared that fertilizer use was lower in 1996 than in previous years. This may have been due to the drought conditions that prevailed for much of the early rainy season. Peanut was grown without fertilizer. In spite of the commonly observed potassium deficiency symptoms in both peanut and maize, only one resident reported using a potassium containing fertilizer (14-14-14). Other residents were aware of the potential yield improvements that could come with using complete (14-14-14) fertilizer; however they believed that using complete is not profitable. No pesticides or herbicides were used in taro cultivation. Some residents reported using pre-emergent herbicide in rice (34%) and insecticides in maize (25%) and rice (24%).

The typical cropping pattern used in the area was one of 3 years of cropping followed by 3 years of fallow. When a parcel of land was newly cleared and burned it was plowed and planted to taro in the first season (in May or June). After the taro was harvested (in January or February), maize or rice was planted in the field at the beginning of the rainy season (May-June). This cereal crop was followed by fallow or by peanuts (sometimes intercropped with a small amount of maize) that were planted in August or September and matured on the residual moisture. Alternatively, peanuts could precede maize in a given field. This cycle was repeated in the third year and then the land was allowed to go into fallow.

Annual crop yields

Yields for the major annual crops cultivated in Halang are shown in Table 4.6 As can be seen in the table, there was considerable yield variation between farms. However, there did not appear to be any significant difference in maize and peanut yields between the early (May) and late (August) planting dates. Yields for all crops were generally low, in spite of the use of significant fertilizer inputs by most households. However, part of this may have been because 1996 was an unusual crop year. There was early season moisture available from a rare April typhoon; however, rainfall for the prime rainy months of June, July and August was well below the 20 year average. This was likely to have had the most severe impact on taro and *palay* *bukid* yields. Farmers were able to adjust maize and peanut planting dates to avoid the worst of the drought since maize and peanut both have shorter growing season requirements.

Table 4.6. Annual crop yields in Halang

Crop	Frequency	Average yield (kg/ha)	Maximum yield (kg/ha)	Minimum yield (kg/ha)
Palay bukid	3	3700	5000	1000
Palay kaingin	25	1100	2500	100
Maize (May planting)	19	1050	4000	50
Maize (Sept. planting)	17	1300	4600	50
Taro	32	2000	6600	400
Peanut (May planting)	23	1000	2400	250
Peanut (Sept. planting)	23	1050	3600	200

Livestock

Livestock were also very common in Halang and were an important component of many household livelihood systems. The most common livestock were chickens (83%), followed by cows (79%), buffalo (67%), goats (31/%), horses (17%) and pigs (10%). Dogs and cats were also common. Chickens were raised for home consumption, although some were sold. Some residents also raised fighting cocks. Cows were used as draft animals (66%) and for sale (34%) while buffalo and horses were used exclusively for work and transportation. Goats and pigs were both raised primarily for sale.

Perennials

Households in Halang also cultivated a variety of perennial crops (average of 7.7 species per household). In total, 25 species were cited by at least one resident household (Table A1.3). Perennials used in the area can be generally divided into two classes: fruit trees and multi-purpose trees. The most common fruit trees in the area were mango (86%), banana (55%), tamarind (45%) and jackfruit (31%). Other, less common fruit species included: soursop (24%), sweetsop (26%), avocado (14%), santol (14%), guava (12%) and star apple (12%). Other species mentioned by at least one household included: coconut, coffee, Philippine lime, cashew, papaya and duhat (*Syzygium cumini* (Linn.) Skeels). Most households had only small numbers of fruit trees with the exception of bananas where the lowest number of plants/household was 10. In contrast to Imbarasan / Himamara, the interviewer I hired in Halang did a much better job helping respondents to identify more of their tree species, even if they only had one or two trees. Sale of fruits was the dominate use of mango (61%), soursop (80%), and tamarind (95%). All other fruit crops were split about evenly between home use and sale.

Households in Halang also made use of several, multi-purpose tree species. The most widely used species are *ipil-ipil* (*Leucaena leucocephala* (Lam.) de Wit) (88%), *aroma* (*Acacia farnesiana*) (79%), *kakawate* (*Gliricidia sepium*) (74%) and *kamatsili* (*Pithecellobium dulce* (Roxb.) Benth.) (55%). Bamboo use was also reported by 38% of households. The most common uses for the first four species were charcoal and firewood. Eighty-one percent of households reported making and selling charcoal during the past year either using trees found in fallow areas on their own land or from unclaimed lands in the *sitio*. *Kakawate*, *ipil-ipil* and *kamatsili* were all also used as small construction timber and both *kamatsili* and *ipil-ipil* were used as cattle and goat feed.

Non-agricultural activities

Charcoal making was the most common non-agricultural activity in the area (81% of households). Off-farm labor was also important for 57% of households and 21% of households reported income from another form of self-employment. One household head was a carpenter, others engaged in small-scale trading.

Household finances

As mentioned in the context of Imbarasan and Himamara, collection of reliable data on household income and expenditures was difficult. However, I think that the data from Halang was the most reliable of the three study sites for two reasons: 1. Halang was a more cash-based economy, as a consequence, residents were more aware of the cash flows in their system; and 2. The interviewer in Halang had worked in the area for some time and had more interviewing experience than interviewers in other sites. So, he was better able to elicit responses from residents, even on this difficult subject.

Income

Resident households reported an average of 3.1 different sources of income. The most common income sources, frequencies and amounts are shown in Table 4.7 Annual crops (83%) and charcoal (86%) were the two most common income sources. Income from animals (43%) and off-farm labor (57%) was also common. On a percentage basis, income from off-farm labor (42%), annual crops (40%) and animals (34%) were the most important components of total household income. In addition, self-employment was a significant percentage (28%) of total household income for those households that had that income source. The average annual household income in Halang was P47,000 with a range from P8,700 to P170,000. These numbers were relatively similar to those found in the 1994 survey (Garcia et al., 1995). However, the role of off-farm labor increased significantly (20% to 57% of total households and 20% to 42% of total income) between the 1994 and 1997 surveys.

Table 4.7. Income sources and amounts in Halang

Income Source	Frequency (% of residents) N=42	Average annual income for those with the income source	Average percent of total income for those with the income source
Annual crops	35 (83%)	17,800	40%
Fruits	3 (7%)	4,100	14%
Animals	18 (43%)	17,100	34%
Charcoal	36 (86%)	7,900	19%
Off-farm labor	24 (57%)	20,900	42%
Self-employment	9 (21%)	16,400	28%

Expenses

Households in Halang reported an average of 3.5 different expenses and an average total household expenditure of P48,000 annually. The major expenses and amounts are shown in Table 4.8. All households reported spending money on food (although not on rice) and on basic household supplies. Significant numbers of households reported expenses related to agriculture (81%) and school for children (55%). Based on percentage of the total household expenses, food (69%) was the most important followed by household goods (20%) and school expenses (13%). Even though the average value and percentage of school expenses were relatively low, they were very important (up to 56% of total expenses) for a small number of families.

Table 4.8. Major expenses and amounts in Halang

Expense	Frequency (% of residents) N=42	Average annual amount for those with the expense	Average percent of total expenses for those with the specific expense
Food	42 (100%)	32,000	69%
Household	42 (100%)	9,100	20%
Agriculture	34 (81%)	2,500	6%
School	23 (55%)	9,100	13%
Other	1(2.4%)	1,000	7%

Net

As was the case in Imbarasan / Himamara, the majority of households reported net incomes of 0 (40%) or reported negative net incomes (36%) ranging as high as -

P93,000. The remaining households (24%) had positive net incomes with a maximum income of P140,000.

Based on my experience in the area, I assigned what I believed to be a reasonable error range on both reported income and expenses (P1000/month either way for both, or a total annual maximum error of P24,000). After assigning this estimated error, 30 households had net incomes not significantly different from zero. Six households (14%) had negative net incomes and six (14%) had positive net incomes.

Credit

Most households in Halang (91%) made use of credit. Four types of credit were available. The first type, used by 31 households (74%) was informal credit advanced by local *sari-sari* store owners. This money was loaned, short-term, without interest, to enable cash-poor households to purchase basic food and household items such as sugar, coffee and soy sauce. Generally the amounts of money loaned were small (average of P5,800 annually) and the money was repaid in a few days or at most a few weeks.

The second type of credit was an expanded version of the first. The three households that had small *sari-sari* stores borrowed money (average of P48,000 annually) in order to purchase items for resale. This credit was short term (days or weeks) and residents reported paying no interest although I believe that they were charged more for items purchased on credit than for items purchased with cash.

Family and friends provided the third reported credit source used by two households in the past year in order to help them meet medical expenses (average of P20,000).

The final type of credit was based on the taro growing system. Only two households report borrowing money for agricultural inputs (average of P3000) but information from my informal interviews indicates that virtually all households engaged in taro production (33 households) received fertilizer on credit from the main taro buyer. Since the fertilizer was provided by the buyer in return for agreeing to sell the taro to that particular buyer at slightly below the market price, residents seemed to place this arrangement in a different mental category than the other types of credit.

Other issues

The possibility of non-agricultural development in the area was the primary issue that was in the background of any and all discussions on the present and future of agriculture in Halang and the future of Halang as a community. The purchase of the land in the southern part of Halang by a large land-development corporation was seen as the first step toward the eventual conversion of the area into high-cost housing for the Manila elite. In my opinion, this was certainly plausible. The area was easily accessible by paved road from Manila, particularly from the rapidly growing eastern side of the city. The views from Halang were spectacular and included Laguna Lake, Mt. Makiling and Mt. Banahaw. However, the fall of various Southeast Asian currencies (including the Philippine peso) against the dollar in 1997-1998 appeared to have slowed the pace of proposed development considerably and may have reduced the pressure on the area at least for the near future.

Residents expressed a range of views regarding their future in the area. A few residents were willing to sell out for modest sums of money and leave almost immediately. At the other end of the spectrum a handful of residents had no intention of leaving at all. The majority of residents fell somewhere between these two groups. Most were willing to leave if they could sell their land for what they consider an appropriate sum of money given its projected use and if most other residents did the same. Under this scenario, families could conceivably make as much as P 3 million - P 4 million for each hectare of land. They talked about investing this money in property elsewhere or in other money-making opportunities such as small businesses. Since the land was part of the agrarian reform program, this conversion was forbidden by existing laws; however similar conversions of agricultural land to residential or industrial uses have taken place in other high-value areas in spite of laws against it.

The second, and more immediate, issue of concern to a growing number of Halang residents were perceived negative changes in the community. Nearly all residents (93%) cited the calm and quiet as the primary benefit of living in Halang and residents talked repeatedly about the close, family atmosphere in the community. However, residents felt this situation had changed over the past few years. Parents of teenagers talked of drugs being available in the local high school and expressed worries about their children getting into trouble. People also expressed increased concern about going out at night, even within the *sitio*. One reason that a number of residents cited for not pushing the local government to improve the road was that an improved road would not only provide better access to residents but would also provide access to the are for undesirable elements (primarily thieves).

Example households

As in the case of Imbarasan / Himamara, I identified eight example households. These households represented four groups of residents determined by their available resources and management strategies as discussed in the methods chapter. Households H1, H2 and H3 had very similar resources but illustrated the impact that a small differences in resources and personal circumstances could have on management strategies. Since I was able to spend more time collecting data in Halang and because I had more complete information from the person who I hired to administer the formal survey, I was able to identify the survey data provided by my key informants for six of the eight example households (H1, H2, H3, H4, H5 and H7). Information for the other two households is based on the formal survey (for H6) and on informal interviews with the head of household and his wife (H8).

Household H1

Example households H1, H2 and H3 provided three examples of the range of management strategies used by the dominant group of households in Halang (48%). This group of households was dominated by the now middle-aged couples who immigrated to Halang as children or young adults in the early to mid seventies as members of one of the six original families. They generally had moderate to large holdings for the area and used an integrated management system that included annual crops, livestock, perennials and sometime included off-farm work depending on specific family circumstances. In spite of their overall similarities, there were some significant differences in management strategies that appeared to be based on small differences in available resources, specific household circumstances and individual preferences. The primary circumstances that differentiated household H1 from households H2 and H3 were that household H1 owned a small parcel of land in *sitio* Kambingan since the husband was one of the few residents not to have immigrated to the area from Batangas, and that the household was relatively more dependent on off-farm income largely because the husband was able to earn good wages working as a carpenter during the dry season.

Household H2

Example household H2 was the second of the three household representatives from the most common group of households. This household used a slightly different mix of strategies than household H1 to respond to similar problems and needs. The major differences in livelihood strategies were that household H2 placed more emphasis on cattle production and that the wife in the household had a small *sari-sari* store.

Household H3

Example household H3 used another, slightly different, set of management strategies. In contrast to households 1 and 2, this household was relatively more reliant on perennial species. This head of this household was also one of the most outspoken persons in the *sitio* about the intrinsic value of land. In spite of the potentially high returns from selling land, he said that he would only sell as a last resort if he was unable to farm.

Household H4

The next two groups of example households, including the small group (2 total households) represented by household H4 were mainly the children of the initial immigrants to the area who were discussed in the previous 3 models. The two groups were differentiated by their access to land. Group 4 had access to relatively large holdings. Example household H4 was a newly married couple who inherited a relatively large parcel from the husband's parents because none of his other siblings wanted to farm. Their overall management strategy was similar to the management strategies used by their parents. However, since they had a low labor-land ratio, they used a more extensive management system with a considerable area left fallow.

Household H5

Household H5 represented the second group of predominately second generation households. This group (24% of all households) differed from the previous group in that their available land holdings are much smaller. There was also some variation within this group, primarily on the aspect of family size. Household H5 was one of the slightly older members of the group with a slightly larger family. They used a similar taro, rice, maize, peanut cultivation system as the system used by their parents and most Halang households. However, since the household had several young children, labor was very limited and was a severe constraint on the amount of land they could successfully manage.

Household H6

The next three household groups represented three very different sets of resource endowments and management strategies. The first of these groups, represented by example household H6 were the most disadvantaged group of households in Halang in terms of access to resources. These households, who made up 12% of the sitio population, either have no land of their own (2 cases) or holdings of less than one-third of a hectare (3 cases). This group used a management system that did not include annual crops and was dependent primarily on livestock and charcoal.

Household H7

In contrast to the previous group of households, this group (of only two households) represented the other end of the resource availability scale. This group had access to *bukid* areas that could be flooded for rice cultivation. By being able to cultivate *palay bukid* with its reduced risk of crop failure and significantly higher yields than upland rice, these households were more willing and able to take risks and to think in the long term about the management of their upland holdings. They also had invested heavily in cattle.

Household H8 (special case)

The final example household (H8) was an example of a unique management system in Halang and one that could be a sustainable alternative management system over the long term. This was a land intensive system based on perennials and cattle, with no annual crops and few fruit trees. Some timber species provided long-term profit potential while day-to-day expenses were met by regular cutting of small multi-purpose trees for charcoal production. The tree leaves were used as cattle feed. This system provided potentially high returns to labor and investment; however it required a large amount of land.

Site #3: Upper Magsaysay, Infanta, Quezon

Community level

The third and final study site consisted of the three upland *sitios*, KM 12, Kakawayan, and KM 9 in the *barangay* of Magsaysay, Infanta, Quezon (Figure 4.5). These three *sitios* were the last three *sitios* as you follow a former logging road into the mountains. As a consequence, I will refer to the area as Upper Magsaysay to avoid having to write out the three *sitio* names every time. Of the three *sitios*, KM 9 was the furthest down the mountain (only 9 km from the provincial highway). Kakawayan was located at approximately KM 10 and KM 12 was further into the

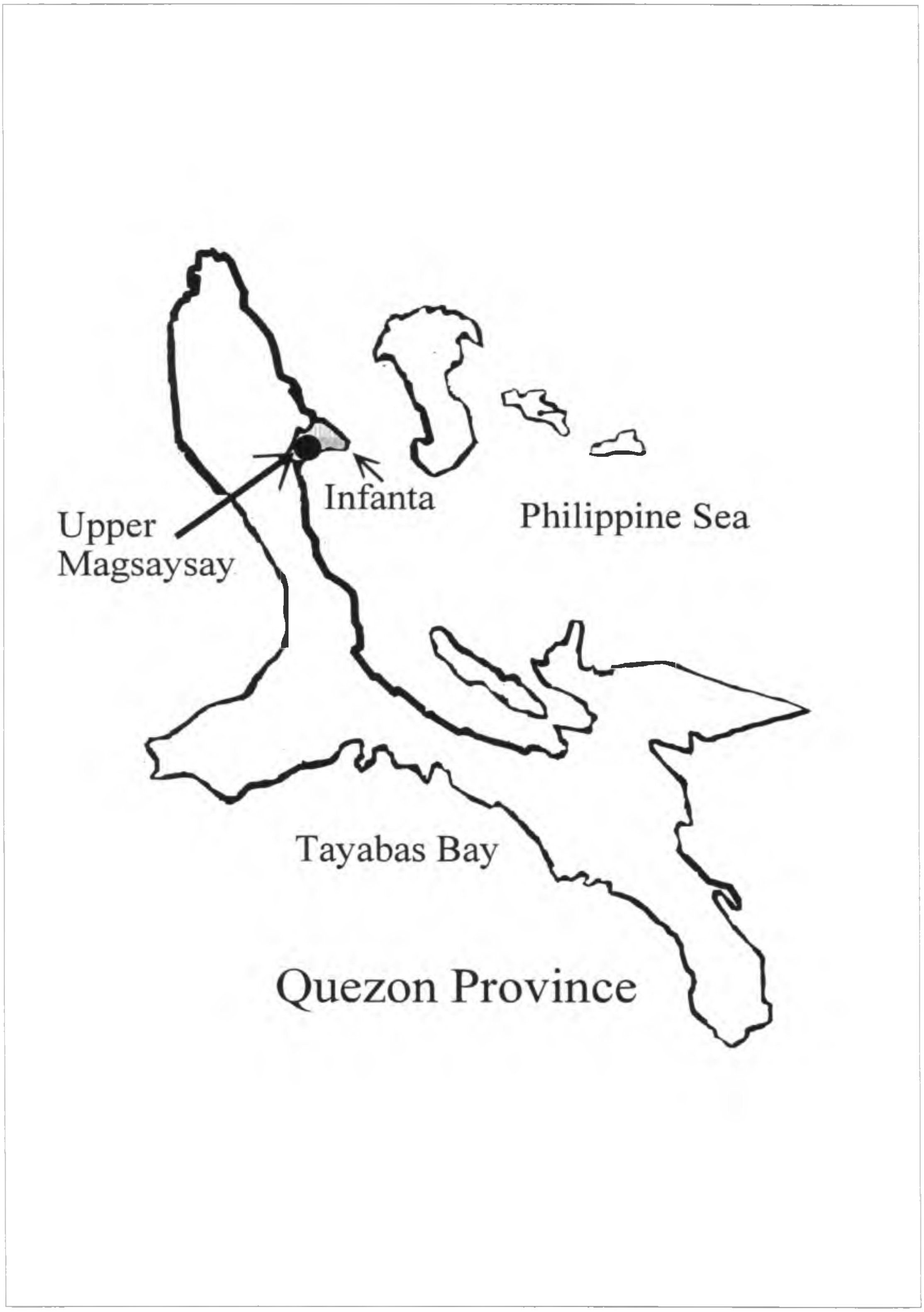


Figure 4.6. Location of Upper Magsaysay

mountains. The junction where the Magsaysay *barangay* road meets the highway was approximately 5 km south of Infanta town.

Physical environment

Terrain

The land in the area was mountainous and was dominated by steep slopes. A small amount of flat land was located along the Agos River in Kakawayan and KM 9. KM 12 is exclusively upland. Elevation in the area ranged from nearly sea level at the riverside to over 800 m in the highest parts of KM 12.

Climate

The climate in Upper Magsaysay was characterized by abundant annual rainfall and the lack of a significant dry season (Figure 4.6). The average annual rainfall in Infanta town was nearly 4000 mm. In addition, the area was regularly hit by strong typhoons concentrated in the months of October, November and December. Although the study area was at a significantly higher elevation than the town proper, residents indicated that rainfall amounts and timing were not significantly different from those in town. Parts of the area were at sufficient elevation to have a noticeably lower air temperature, particularly at night and during the winter season.

Soils

Soils in Upper Magsaysay were highly weathered. They were of generally low pH and had low levels of phosphorus and potassium. Calcium and magnesium levels were low to moderate. Organic matter levels were high in soils that were newly

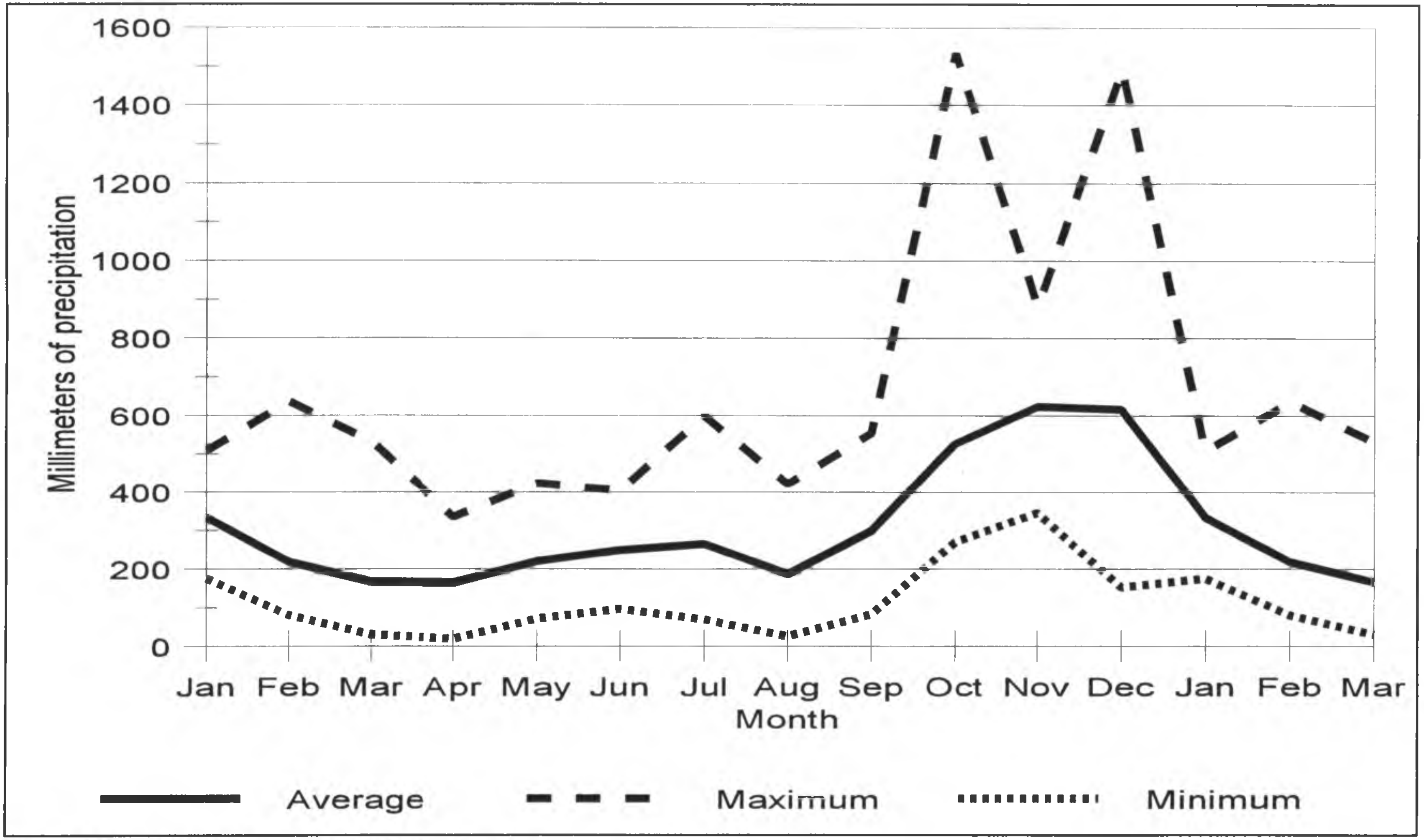


Figure 4.7. Rainfall pattern in Infanta, Quezon

cleared; however, organic matter content rapidly decreased with cropping (Table 4.9). Research in other locations has shown aluminum toxicity to be a limiting factor for crop growth on similar soils (Wade et al. 1988). At present the exchangeable aluminum levels in area soils were generally below the levels thought to be limiting to the common species grown in the area. However, exchangeable aluminum levels were likely to rise with an decrease in soil organic matter content.

Socio-political environment

Land status / classification

All three of the study communities that make up Upper Magsaysay were officially located in a national park. The area was designated a national park in the 1976 (Presidential proclamation 1636) under the Marcos administration. Most of the residents were already living there at that time. Officially the area was administered by the protected areas division of the DENR and residence in the area by anyone other than "cultural minorities" was forbidden. However, in the last two years there has been increasing recognition within the DENR and the government in general that simply banning people, especially long-term residents, from these areas would be counter-productive. As a result, protected areas were slated to be added into the ISFP (described earlier for Imbarasan / Himamara). At the time of this research, the DENR had started a census of area occupants as a precursor to the setting-up of an Integrated Social Forestry Program (ISFP) project area. However, this process was still ongoing when I finished my field activities in December, 1996. Twenty-five (63%) resident

Table 4.9. Soils in Upper Magsaysay

Location	pH	% OM Walkley-Black	P (ppm) Bray 2	K (me/100g) NH4OAc	Ca (me/100g) NH4OAc	Mg (me/100g) NH4OAc	Al (me/100g) KCl	% Al Saturation
KM 12 Set 1 n = 4	4.7-4.9	2.40-5.42	0.35-2.46	0.73-0.82	9.60-15.25	2.04 - 6.12	0.56 - 1.54	5.5 - 7.6
KM 12 Set 2 n = 5	4.4-4.5	4.03-6.02	0.35-1.76	0.21-0.54	2.89-6.44	0.96-2.88	0.23-1.49	5.1 - 18.1
KM 9 n = 1	5.3	8.09	2.11	0.35	14.33	4.2	none	none

households reported having some sort of paper establishing their claim to their land holdings with 10 of those (40%) reporting having a CSC (Certificate of Stewardship Contract) from the ISFP, 9 (36%) a land title and 6 (24%) a tax declaration.

Governance

The area was officially part of the *barangay* of Magsaysay which was one of 36 *barangay* in the municipality of Infanta. The *barangay* and municipality were governed by a *barangay* and municipal council as discussed for the other two sites. The bulk of the population and political power in Magsaysay was centered nearer the highway around KM 3 where the barangay hall and health center were located. One member of the barangay council resided in Kakawayan.

Infrastructure and services

The provision of infrastructure and services had an important impact on both the existing management systems in Upper Magsaysay and on the potential for development of alternative systems.

<u>Roads and transportation</u>

The three communities were connected to the main highway via an all-weather but poorly maintained road that generally follows the Agus River to the west, into the Sierra Madre mountains. The road was reasonably well maintained until the center of Magsaysay at KM3 and deteriorated after that although it was still passable by *jeepney* as far as Kakawayan. KM 12 was connected to KM 9 via an abandoned logging road that was passable to *jeepney*s until a landslide washed out a portion of the road in 1994. At the time of the research, it was only passable to foot and animal traffic.

Two *jeepneys* (one from Kakawayan and one from KM 9) provided regular service, at least one and sometimes two round trips daily, between the area and Infanta town. The trip between KM10 and Infanta town took approximately 2 hours and cost P25. The road was generally open year-round but was occasionally closed for a few days following severe storms. With the completion of the new highway between Infanta and Manila via Siniloan (opened in early 1996), the trip between Manila and Infanta took about 3 hours by private vehicle and less than 5 hours by bus.

Utilities

There were no utilities, water, electricity or sanitation available in Upper Magsaysay. The lower parts of *barangay* Magsaysay (up to about KM 3) had electrical service but it had not been extended any further up the road. Residents in KM 9 and Kakawayan obtained their household water, including drinking water, from shallow wells while residents of KM 12 relied on natural spring water for all their household water needs. Similarly, sanitation in the area was decidedly low-tech and consisted of a few pit privies in the more populated areas of Kakawayan and no facilities in other parts of the communities. .

Schools

An elementary school, grades K-6, was located in Kakawayan. For children who wanted to continue beyond elementary, there was a public high school as well as a Catholic high school in Infanta town. However, it was not practical to commute daily from the area to town so high school attendance required that the student have a place to live in town, either with relatives or as a paying boarder. Several area residents had taken advantage of a program administered by ICDAI, a local NGO, that provided students with scholarships to defray all or part of the cost of their high school studies.

Medical care

Medical care in the area was confined to traditional practitioners. The *barangay* health center was located in Magsaysay proper. Area residents sought the services of doctors and the hospital in Infanta town for more severe conditions.

Markets

The principal market for area products was the town of Infanta. Area residents took their produce to the Infanta market and sold it, usually through market vendors. This had been a problem for area residents since Infanta was not a large town and therefore the market was rapidly saturated by in-season produce. This led to sharp drops in prices. With the opening of the new road to Manila, opportunities for selling agricultural products (ginger, pineapple, citrus) directly to Manila could open up but residents had not taken advantage of this situation at the time of the study. Forest products (esp. timber) were not typically sold in the market but were sold using a system where the harvester transported the rough sawn timber to the *barangay* road where it was collected by the buyer in their own vehicle. Most of these buyers, although located in Infanta, shiped directly to the Manila area.

Information availability

Information on many aspects of land management was definitely in short supply in Upper Magsaysay. There was no organized activity in the area by the DENR or any other government agency at the time of the study. ICDAI, a very successful local NGO, had started working in the area in conjunction with the FAO-funded FARM Programme. However, these activities were largely still in the planning stages during the time of this research. ICDAI did not have much experience working in upland areas; however, they had hired at least one new graduate from the Social Forestry Program at UPLB to help plan and coordinate upland activities.

Demographics

Population

Based on 1995 census figures, the population of *barangay* Magsaysay was 1,938 persons residing in 351 households (RP-NSO, 1995). The survey that I had administered as part of this study enumerated 218 residents in 41 households in the study communities of Upper Magsaysay.

Settlement pattern

Settlement in the area was concentrated along the road and was further concentrated in three places. KM 9 was located roughly where the old logging road to

KM 12 branches off from the main road that continues to follow the Agos River. Kakawayan, the largest settlement and where the elementary school was located is approximately 1 km further up the road along the river. The road then ended soon after Kakawayan. Another group of houses was located about 3 km up an old logging road roughly south of KM 9. Houses were also scattered along the road between KM 9 and Kakawayan and a couple of houses were located along the road between KM 9 and KM 12. Fields were typically located in back of dwellings. In addition, most residents claimed use rights over parcels of land in other parts of the area, especially further into the mountains.

Ethno-linguistic background

The vast majority of local adult residents (86%) were members of the Tagalog ethno-linguistic group and Tagalog was the lingua franca of the area and was spoken by all adult residents as either a first (86%) or second (14%) language. The second most common group were the Bicolanos (10%) from southern Luzon who largely came to the area as employees of the logging companies and stayed. There was also one resident each from the Cebuano, Hiligaynon and Ilocano ethno-linguistic groups.

Household attributes

There were 41 households residing in Upper Magsaysay with an average household size of 5.3 persons. Thirty-five household (85%) were centered around a married couple and their children while there were six, single-adult headed households including 5 widows and one widower. Three households had only one resident while the largest household has 11.

Settlement history and changes over time

Upper Magsaysay was settled fairly steadily over the past 70 years. The first arrivals in the area settled lands near the river in KM 9 as early as the mid 1920's. Settlement continued to steadily expand further into the mountains and the years of residence was strongly correlated with farm location (Pearson's $\rho = 0.44$, $P(\rho = 0) < 0.01$) with KM 12 settled the most recently. Current residents had lived in the area for an average of 27.4 years with the first residents arriving in the 1920's and the most recent in 1994. Taken by decade, the largest percentage of community residents (37%) arrived between 1975 and 1984 followed by 1955-1964 (18%), 1985-1995 (14%), 1965-1974 (12%), before 1945 (10%) and 1945-1954 (9%). The vast majority (73%) of current adult residents either grew up in Upper Magsaysay or elsewhere in the Infanta area. Another 15% came from nearby Tagalog speaking provinces and 9% from the Bicol region of southern Luzon. Of those residents who stated why they came to the area (n = 37), the majority (51%) came looking for land to farm or to improve their livelihood. An additional 28% grew up in the area and 13% arrived as logging company employees, married locals and stayed.

The principal changes in the area over time were logging and the continued expansion of settlement. Most of the commercial logging activities in the area took place in the late 1970's and early 1980's. All of the commercial timber in these areas has been removed although illegal commercial-scale logging was still taking place in areas further to the north and west of the study communities. However, unlike in Imbarasan / Himamara, ample evidence of logging existed in Upper Magsaysay including a still passable logging road and various pieces of abandoned equipment. Hardwood trees, principally red lauan (*Dipterocarpus* spp.) that were too small for commercial harvest were still available and were being harvested by area residents and sold for timber. Settlement in the area had followed the logging roads into the mountains. However, ample land remained available and a long-fallow *kaingin* system was practiced in hillside areas as it had been since the areas were originally settled. A small amount of permanent field cultivation existed in the limited flat land near the river in KM 9 and Kakawayan and significant areas had been planted to perennials, mainly coconut. However, with the collapse of the copra market, some residents had turned to other trees including citrus species and coffee.

Resources

Land

The major resource available to residents was land. Based on survey information, the total amount of land claimed by community residents was 532 ha. The average size of land holdings in the area was 13 ha; however holding size ranged from a low of 0.5 ha to a high of 73 ha. Approximately one-third of residents (14) claimed 5 ha or less. Another one-third (13) claimed between 6 and 10 hectares. The remaining one-third (14) claimed larger parcels. The size of land holdings was significantly positively correlated to years of residence in the area (Pearson's ρ = 0.34, $P(\rho = 0) < 0.05$). All residents had upland holdings (average 12.5 ha) while 8 residents reported lowland holdings (average size 1.4 ha). As mentioned in a previous section, most households had claimed ample land to support an extensive agricultural system based on long-fallow shifting cultivation. However, some households, largely second-generation households in KM 9 and Kakawayan only had access to very small holdings.

Unclaimed land

It was virtually impossible to determine the area of the study communities since they were the last communities in *barangay* Magsaysay and the *barangay* extends on into the mountains to the municipal boundary. A conservative estimate of the unclaimed land area accessible to residents was at least 2000 ha. Settlement had concentrated on the most accessible and flattest lands leaving the unclaimed lands located on very steep slopes and further up into the Sierra Madre mountains. Communities of the Dumagat people (a "tribal" group) live in the higher mountain areas; however ,community residents did not report having any interaction with them.

Land classification

Residents of Upper Magsaysay reported an land classification system that was virtually identical to the system described for Halang. Unclaimed lands and lands covered with secondary forest vegetation were classified as *gubat*. Sloping lands that were currently used for agriculture and planted without plowing or had been used for agriculture in the relatively recent past were classified as *kaingin*. The term *bukid* was used to describe lowland areas that could be plowed. Areas dominated by a single species were classified using the *-(h)an* suffix (e.g. *niyugan* – coconut orchard).

Activities and Enterprises

The local livelihood system was based on a relatively small number of activities and enterprises including long-fallow *kaingin* cultivation of annuals, cultivation of a few perennial species, and harvest of forest products including grasses and palms, rattan and timber. Some livestock were present in the area but only in limited numbers. Other livelihood activities were important for a small number of families and include a driving a *jeepney* (owned by the richest household in the community), receiving money from children working abroad, and working off-farm.

Annual crops

The major annual crops cultivated in the area were: ginger (56%), cassava (49%), *palay kaingin* (44%), pineapple (32%) and taro (24%). Other, less common, crops cultivated include *palay bukid*, sweet potato, yautia, and some vegetables. For those without access to lowland areas (83%), the typical management system involved clearing a new parcel of land, typically 1 ha or less in size. Most parcels cleared have brushy, second-growth forest fallow. The slash was allowed to dry as much as possible and the area was burned during the driest part of the year (March and April). Because there was no true dry season, burning was often difficult and most fields I observed had significant debris that had not burned during the initial clearing phase.

During the first year, rice was planted in the area. The typical varieties use were Philippine developed improved varieties BS-1 and C-4 Residents reported that reasonable rice yields could only be obtained for the first year so. After the rice was harvested, the typical practice was to plant a cassava / pineapple intercrop. This second phase usually included ginger and sometimes also included taro, sweet potato and some fruit tree seedlings (primarily coconut). The land was managed under this integrated cropping system for 2 or 3 more years (first pineapple crop and a ratoon crop) and then was left fallow. If coconut or other fruit tree seedlings had been planted, the area was managed as an orchard. Otherwise, it reverted to secondary forest fallow.

Ginger had become an increasingly important component of household livelihood systems in the area. It was well adapted to the area, easy to transport and commanded a good price in the market. A majority of households (56%) were cultivating ginger and several had planted significant areas (up to 0.5 ha). No residents mentioned ginger during my limited informal interviews in the area, so I was not certain of the management details. Given that residents cited it as a valuable cash crop, I assumed that it was planted either in newly cleared areas instead of rice or as a second-year crop immediately after rice that was a precursor or substitute for the more traditional pineapple - cassava system.

Seven households (17%) had lowland holdings near the river where they planted at least one and usually two crops of *palay bukid* (usually BS-1 or IR 64). As a consequence, these households did not grow rice on their upland holdings but instead typically grew cassava, pineapple and ginger. They were also more likely to manage their uplands for fruit trees including coconut, banana and citrus.

All annual crops were managed in a very low input system. Only 5 households reported using fertilizers and 5 households reported using pesticides. Four of these households used fertilizer (14-14-14) and pesticides on *palay bukid* while one household used chemical inputs in vegetable production.

Because most residents did not provide estimates of plot sizes in the formal survey, estimating yields for annual crops was difficult. Table 4.10 summarizes the yield information for the major crops in the area but was based on very limited data. In spite of its importance in the area, pineapple was not included in the table because no household provided data on pineapple yield.

Table 4.10. Annual crops in Upper Magsaysay

Crop	Number who reported plot size	Average Yield (kg/ha)	Total number including plot size estimated from reported seeding rates*	Average Yield (kg / ha)
Palay kaingin	2	1600	3	1730
Palay bukid	8	380	18	370
Ginger	4	1100	15	520
Cassava	3	3670	8	3750

* The following seeding rates were assumed: *palay kaingin* 25 kg/ha, *palay bukid* 100 kg/ha, ginger 150 kg/ha, cassava 10,000 cuttings/ha.

Rice was used exclusively for home consumption by area households and even with rice they produced, most households still needed to buy some rice during the year. Most households used cassava (80%) and taro (71%) for home consumption. The remaining households grew these crops primarily for sale. Ginger and pineapple were produced for sale while the remainder of the crops grown in the area were used for home consumption.

Livestock

As mentioned in the section introduction, livestock were not a very important component of the livelihood system in these areas. Two households owned no animals at all and two others owned only dogs or cats. The most common livestock in the area were chickens (83%), buffalo (39%) and pigs (39%) (Table A1.2). One household had 3 cows and three households owned horses. Ducks and doves were raised by one household each. Households owned an average of 8 chickens that were used for home consumption (meat and eggs). Two residents reported raising fighting cocks. Buffalo and horses were used as work animals. The resident with cows wes raising them for sale, while pigs were raised for sale (64%) and home consumption (36%).

Perennials

Activities associated with the management and harvest of perennial species were of significant importance to a large majority (76%) of households in the community. A total of 35 perennial species were used by one or more households with households using an average of 6.3 species (Table A1.3). All households used at least one perennial species. Two general classes of perennials were used in the area:

those cultivated on household land holdings and those obtained from unclaimed lands further into the mountains.

Perennial species found on household land holdings were mainly fruit tree species. The most common species were: coconut (78%), jackfruit (63%), banana (61%) and citrus (61%). Other common species included: avocado (46%), narra (46%), gmelina (27%), santol (24%) and coffee (20%). Coconut and citrus were grown primarily for sale. Coffee use was evenly split between home consumption and sale. All other fruits were grown primarily for home consumption although surplus production could be sold. The two non-fruit species mentioned, narra and gmelina, were both being grown with the eventual goal of sale and a few residents had already been able to sell narra. However, most of the timber trees planted on individual holdings had not yet reached harvest size.

Residents perceived perennial crops as the most resilient option given their environmental conditions. In the past, coconut for copra production had filled this role and was the major economic product of the entire Infanta area. However, with the severe drop in world demand for coconut oil, copra prices were so low that most residents were not even harvesting their coconuts and a few had started cutting down the trees for wood. Others were still maintaining and even in some cases enlarging their coconut orchards in the hope that prices would recover. Citrus and more recently coffee were seen as a promising alternatives to coconut. The trees were not hurt by the rainy climate and were relatively wind resistant. However, the households who planted the first large citrus groves reported some pest and disease problems. In addition, citrus seedlings were expensive and grafted planting materials were believed to be essential to ensure quality yield. This made it difficult for limited resource households to start growing citrus. Coffee was a relatively recent addition to the system but likely faced many of the same problems as citrus. Another advantage of both coffee and citrus (if used for juice) was transportability. As mentioned above, access to the area was difficult and a product needed to be strong enough to arrive in either Infanta or Manila in marketable condition.

A large number of other fruits could potentially do well in the Upper Magsaysay climate and could tolerate the soils; however many of these species could be severely damaged by the high winds that accompany the typhoons that hit the area with an average frequency of 5 storms in every 3 years (EMB-DENR, 1990). Most residents still planted bananas since they required low initial investment and generally recovered quickly from storm damage. However, residents expressed a reluctance to experiment with other, potentially more valuable fruits, given the initial time and monetary investment involved, transportation and marketing issues and the risk of typhoon damage.

Although fruit trees were important in the area, the harvest of forest products, primarily timber and rattan, from unclaimed lands further into the mountains had a much greater impact on household livelihood systems in Upper Magsaysay. Nearly one-half of all resident households reported cutting down timber trees and selling the wood as a source of cash income. These trees harvested were primarily red lauan (Dipterocarpus spp.) that were too small to be harvested by the commercial logging companies but had reached the size where they could be profitably harvested by a couple of men with a chain saw and a water buffalo. Lauan was a high quality tropical hardwood that was valued as a building material. When finished, the wood had a reddish color and could also be used for furniture.

A significant percentage of households (39%) reported harvesting other forest products for sale. These were primarily rattan species that were used in handicrafts and furniture making. In addition to rattans, residents reported harvesting *anahaw* (*Livistona rotundifolia* (Lam.) Mart.), a palm species used both in construction and in handicrafts and both *cogon* (*Imperata cylindrica*) and tiger grass (*Thysanolaena maxima* Roxb.). *Cogon* ws used for roofing material while tiger grass was used to make the soft brooms that are commonly used in Philippine households. While most households reported harvesting either timber or non-timber forest products, 6 households were involved in both activities.

Non-agricultural activities

Although off-farm activities (excluding timber harvest) were not as common in this community as they were in other communities, they still were important to some households. Eight households (20%) relied on off-farm labor in agricultural tasks to provide a portion of household income. Other off-farm sources of livelihood that impacted specific households included children abroad who sent back money on a regular basis (two households), owning a *jeepney* , a small *sari-sari* store , carpentry and basket making, and taking in laundry.

Household finances

As mentioned in the discussions of the first two study sites, income and expense information taken from household surveys is often not completely accurate. However, I believed that the types and general ranges of income and expenses given by residents provided a good picture of the current situation even if the exact numbers were likely to be somewhat suspect.

Income

Community residents reported an average of 2.0 income sources per household and an average annual income of P35,600. Income levels ranged from P0 (2 households) to P223,000. The most common sources of income were forest products (26%) and crops (24%). Other less common sources of income that were important to specific households including the sale of fruits, off-farm employment in agriculture, self-employment activities and money from children working abroad (Table 4.11). Forest products (73%) retained their relative importance when the criteria of percentage of total household income is used. However, it was readily apparent that other, less common income sources such as fruits (73%), self-employment (72%) and income from children (87%), were very important for a small number of specific households.

Table 4.11. Income sources and average amounts in Upper Magsaysay

Income source	Number (% of residents) N = 41	Average annual amount for those with this income source (pesos)	Average percent of total annual income for those with this income
Forest products	26 (63%)	30,500	73%
Crops	24 (59%)	6,600	34%
Off-farm ag labor	9 (22%)	11,800	43%
Fruits	4 (10%)	7,400	73%
Self-employment	3 (7%)	40,800	72%
Income from children	2 (5%)	120,000	87%

Expenses

Households in Upper Magsaysay also had significant expenses. Households reported an average of 3.3 expenses and average total annual expenses in the amount of P31,000. Total annual expenses ranged from a low of P4000 to a high of P62,400. All households reported spending money to buy food. Of these households 59% explicitly reported buying rice. However, based on estimated rice yields, I inferred that very few, if any, households in the area were self-sufficient in rice. The other commonly reported expenses were for household needs (90%) and for schooling (71%). Other uncommon expenses were medical expenses (3 households), expenses related to agriculture (1 household) and other miscellaneous expenses (2 households). On the basis of average importance within specific households, food (66%), household expenses (24%) and school expenses (17%) were again the most important (Table 4.12).

Table 4.12. Major expenses and amounts in Upper Magsaysay

Expense	Number (% of residents) N = 41	Average annual amount for those with this expense (pesos)	Average percent of total annual expenses for those with this expense
Food (including rice)	41 (100%)	20,500	66%
Household	37 (90%)	6,700	24%
School	29 (71%)	6,100	17%
Medical	3 (7%)	1,100	5%
Agriculture	1 (2%)	1,500	11%
Other	2 (5%)	800	6%

Net

Unlike the previous two study communities, the average net annual income in Upper Magsaysay was slightly positive (P4,600). However, a slight majority of residents (21 of 41) reported net negative incomes with the lowest reported income of -P49,400. The highest reported net income was P191,500 from the household with the most land and the *jeepney*. Taking the same error allowance as in the previous two sites (P12,000 either way for both expenses and income) resulted in 61% of households having reported net income not significantly different from zero. Twenty percent of households still reported negative net incomes and the remaining 20% reported positive net incomes.

Credit

Residents of Upper Magsaysay made some use of credit in their livelihood system; however only 37% of residents reported borrowing money in the past year. The majority of these borrowers (64%) borrowed from friends or relatives to meet food, household or medical expenses. Three households received advances on their timber harvest from timber buyers and used this money to meet immediate living expenses. The amount of money borrowed was small, all but one borrower reported borrowing P6000 or less, credit was short term, and no interest was charged. Two residents reported borrowing significant sums of money (P18,000 and P150,000) to meet expenses associated with sending one of their children to work abroad. Both borrowed from the labor recruiter and were charged interest at 10% per month, equivalent to 214% annually.

Other issues

Although the issues of land status and access in Upper Magsaysay were discussed previously, in order to better describe the situation, I have included additional related information on these issues. First and related to the land issue, there was considerable press coverage and political fallout in late 1996 from the activities of the barangay captain in Magsaysay. He was suspended for giving residents certificates of ownership (not legally binding) to their holdings in the barangay. Since the area was officially national park, he had no authority to issue such documents. The whole situation might have blown over had it not been for the activities of a large logging company in the area. This company, reportedly based in Taiwan, offered to pay residents cash for their land certificates with the supposed intent of claiming the area and harvesting timber. Although the situation was legally very straight-forward – the government owned the land, the only individuals who had any potential rights to it under present Philippine law were long-time residents who become part of the proposed ISFP site – it was causing considerable concern in the area. In addition, area residents were much more skeptical about CSC's (long term leases from the government) than the residents of Imbarasan / Himamara. As one resident put it: "*Contrata lang iyon, kung gusto nila, wala na, sa kanila lang ang lupa mo*", It's only a contract, if they (rich and powerful people) want, it's gone and your land will go to them.

The second related background issue was the proposed construction of a road directly from Infanta to Marikina (a town just east of Manila) that would go directly through KM 9 and KM 12. This road was originally proposed during the mid-1970's in the Marcos administration and has remained a proposal ever since. More recently, the Ramos administration had expressed interest in developing the Infanta area and surrounding towns as tourist destinations and potentially as a cargo port (in General Nakar, to the north of Infanta, at the mouth of the Agos River). The recent improvement of the road from General Nakar through Infanta to Real (along the coast) and over the mountains to Siniloan was seen as the first step in this process. Continued development of the area could lead to a reactivation of plans to build the Infanta-Marikina road. Construction of this road would greatly alter the situation in the study communities. They would be readily accessible and less than 2 hours driving time to Manila. This has the potential to open a tremendous amount of management options to residents, if they can retain control over their land.

Example households

Using the criteria of available land resources and primary livelihood system components as discussed in the methods chapter, I identified four groups of households in the study communities. These households formed the basis for the four example households.

Since I was unable to spend a large amount of time in Upper Magsaysay, the descriptions of these example households were less grounded in specific informants than the descriptions in Imbarasan / Himamara and in Halang. Only one of the four example households (UM 1) wa based on survey data enhanced by specific key informant interviews. The remaining three models were developed from survey responses and general community information.

Household UM1

Household UM1 represented the most common mix of livelihood strategies used by area households (44% of all households). This strategy involved *kaingin* cultivation with *palay kaingin* and ginger as the most important crops. The household also raised some fruit trees. The primary income source for this household and other similar households was the harvest and sale of timber from the unclaimed lands in the mountains to the west and south of the communities.

Household UM2

Household UM2 represented the second major set of management strategies in Upper Magsaysay (20% of households). Households in this group had only upland holdings and were dependent on a mixture of annual crops, fruits and on income from the harvest and sale of rattan, a non-timber forest product (it is a climbing bamboo).

Household UM3

The third group of households in Upper Magsaysay, represented by example household UM3 made up 15% of the total area households. The major distinguishing characteristic of these households was that they have small parcels of lowland that were suitable for the cultivation of *palay bukid*. These parcels were located in KM9 and Kakawayan on the upper terraces of the Agos River flood plain.

Household UM4

Household UM4 represented the last major group of household in Upper Magsaysay (17%). These households did not have *bukid* available and they did not harvest forest products (timber or rattan) for income. Instead, they were dependent on cash coming from kids abroad or from off-farm work to meet household expenses.

Comparisons between study sites

The preceding three sections have described each of the three study communities and the common livelihood systems in these communities. In this section, I compare the communities and associated livelihood systems and discuss some of the major similarities and differences between the areas. In theory, this discussion could include all of the characteristics mentioned in the systems descriptions. However, in this section, I concentrate on a small number of the most important areas for comparison: land type and availability, land use rights, climate and soils, accessibility and markets, settlement history, major livelihood system components, income and expenses and local perceptions of problems and good things about their community.

Land type and availability

The first major area for comparison between communities was in the amount and types of land available. The total amount of land available differed between communities. In general, residents of Halang had the smallest holdings (average 2.7 ha). Holding sizes in Imbarasan / Himamara were slightly larger (average 2.9 ha), but not significantly different from holding size in Halang. However, total holding sizes in Upper Magsaysay (average 13.0 ha) were significantly larger than in the other two locations.

The differences in absolute land size discussed above did take into account land quality. A smaller amount of higher-quality land may be facilitate the development of a more productive and sustainable household livelihood system than a larger amount of lower-quality land. Even though all three of the communities were upland communities the types of land available were very different in the three sites. The Imbarasan / Himamara area was made up of both valleys and associated hillsides. Therefore, there was much more valley land available for residents and as a consequence, most households had access to at least one small parcel of valley land that could be flooded in rainy season for rice cultivation. In contrast, valley land was much rarer in Halang and Upper Magsaysay. There was only a very small amount of valley land in one corner of sitio Halang and it was used by only a few residents. In Upper Magsaysay, the only valley land available was in the river flood plain. As in the case of Halang, the area was very small and only a few residents have lowland parcels.

Since rice is the major Philippine cereal grain, households need to grow rice or buy rice to meet household food needs. *Palay bukid* was considerably more productive than *palay kaingin* and yields were more stable in the face of water stress. As a consequence, most households in Imbarasan / Himamara were self-sufficient in rice while most households in Halang and in Upper Magsaysay were not. Rice self-sufficiency was an important household goal expressed by informants in all sites and the presence or lack of rice self-sufficiency appeared to have a significant impact on a number of management decisions.

Land use rights

Closely related to the issue of land availability was the issue of land use rights and tenure security. The three sites illustrated part of the range of tenure arrangements and land use rights that existed in the upland Philippines. In theory, inhabited upland areas in the Philippines should fall under the jurisdiction of the Integrated Social Forestry Program (ISFP) of the Department of Environment and Natural Resources (DENR). This program was developed specifically to address the situation faced by upland dwellers. However, of the three study communities, only Imbarasan / Himamara fit the standard model. Upper Magsaysay, since it sits in a national park, was not originally covered by the ISFP. The government had only recently recognized the need to provide residents of national park areas (who were there before the area was proclaimed a national park) with the same sort of tenure security afforded other upland residents. Halang represented a slightly different situation. Since the area was relatively close to Manila, the cattle ranches that used the land up until the 1950's owned their parcels. With the collapse of the free-range cattle market, the area was abandoned (but not sold) and was settled by upland farmers. Since the owners were known, the area came under the jurisdiction of the Department of Agrarian Reform (DAR).

There were two primary impacts of these differing jurisdictional regimes. First of all, residents could claim different sizes of holdings. Under the ISFP, the maximum area was 5 ha while under DAR the maximum was 3 ha. In addition, the price and eventual disposition of the land was different. Under the ISFP, the resident paid no fees, but the land was never owned by the resident. Tenure consisted of a renewable, inheritable, 25 year lease. Under DAR, the resident eventually owns the land outright; however, they must pay back the government for the purchase price of their land.

The limit on land size was likely to have the most significant impact on management, particularly in the next generation. A three hectare upland holding was a small area on which to practice a fallow-based management system and already had led to the short fallow periods seen in Halang. With the mixture of lowland and upland available in Imbarasan / Himamara, five hectares seemed to be a reasonable land holding size. In Upper Magsaysay, five hectares may even be too small an area to effectively practice the long-fallow systems necessary to effectively manage these lands under current practices. In all three cases, holdings were likely to continue to decrease in size as they were passed on to the next generation. This was already noticeable in Imbarasan / Himamara. It was less noticeable in Halang, because of the large amount of out-migration of young people and in Upper Magsaysay where ample vacant land was still available and young couples could settle new areas.

Climate and soils

The climate and soils of the three communities were very different and interacted with the land availability and tenure issues mentioned above. Rainfall and soils are two of the fundamental constraints on management system choice, particularly in these systems where measures to change either of these resources (e.g. irrigation development for water or fertilizer use to improve soil fertility) were prohibitively expensive for most residents. Different constraints were operating in each of the three areas. Management in Imbarasan / Himamara was constrained by the severe dry season. It was also constrained by soils in some areas. However, other areas such as the alluvial valleys and some very fertile areas at slightly higher elevations had far fewer soil constraints. Halang had a similar climate to Imbarasan / Himamara with a larger water availability problem, especially in dry season. Halang soils were generally more fertile overall; however, they were extremely shallow.

These shallow soils and the exposed ridge-top location of much of the sitio served to constrain management choices, particularly options related to perennial species. Upper Magsaysay had the opposite problem. The high rainfall in the area had led to the development of highly leached and generally infertile soils. In addition, the heavy rainfall and regular typhoons limited management options.

Accessibility and markets

The three areas also had significantly different levels of accessibility, particularly accessibility to markets for agricultural and forest products. Upper Magsaysay was at the greatest disadvantage. It was located the furthest from a good road and in an area with no large municipalities. However, Upper Magsaysay residents produced one high-value product (timber) that buyers were willing to invest time and money to obtain directly from the community. Parts of Imbarasan / Himamara were highly inaccessible in rainy season also. However, most of the area was relatively more accessible then Upper Magsaysay. In addition, San Jose was a larger town than Infanta and provided more marketing opportunities. This situation may change with the opening of the new highway from Infanta to Manila in 1996. Upper Magsaysay residents may be increasingly able to take advantage of the large and lucrative Manila market. Residents of Halang had already made this transition and had taken advantage of their favorable location and proximity to Manila to develop a market-based system. They were looking for other opportunities, such as vegetables, that would allow them to further benefit from their location.

Settlement history

Although the average years of residence in the three communities were not significantly different (21.4 years in Imbarasan / Himamara, 21.5 years in Halang, 27.4 years in Upper Magsaysay); the three communities had very different settlement histories. Imbarasan / Himamara was settled primarily by migrants from other islands who either immigrated to the communities by themselves or with a small group (e.g. two or three brothers). They received no government support and were generally on their own. Halang, in contrast, was settled as a community. Virtually all residents were members of one of a small number of extended families who all migrated from one particular town in Batangas. Upper Magsaysay exemplified a third type of settlement. Most of the residents had migrated up the hill from the lower parts of *barangay* Magsaysay or from other parts of Infanta or nearby towns.

Major livelihood system components

The major livelihood system components also differed between the three communities. Residents of Imbarasan / Himamara practiced a livelihood system based primarily on the cultivation of annual crops, mainly for subsistence but increasingly for sale. Perennials and livestock were also important and their importance appeared to be increasing. Off-farm employment was an important component of household livelihood systems.

In contrast, most Halang residents had a livelihood system based on some combination of taro, cattle and charcoal. Perennials, other than multi-purpose trees for charcoal production, played a less important role in this system and cattle and taro played more important roles. The system in Halang was much more market oriented than systems in the other two sites. Virtually all Halang residents were involved in production for sale and were dependent on outside inputs, including food as well as agricultural inputs, to maintain their livelihood system.

Upper Magsaysay was an example of a very different strategy based primarily on extractive activities (timber and rattan harvesting). Livestock were virtually non-existent. Perennials were common but mainly used for household consumption since the collapse of the copra market several years ago. Annual crops raised for subsistence production were a component of the system, but yields are very low due to the unfavorable soil conditions in the area.

Income and expenses

Average annual household income and expenses, as well as per capita income varied between the communities (Table 4.13). Average income increased from Imbarasan / Himamara to Upper Magsaysay to Halang; however, only the difference between the first and third communities was statistically significant. Incomes in all three sites were under the national average rural family income level of P53,500 (RP-NSCB, 1997).

On a per capita basis, the average income in all three communities was above the government identified poverty line for the Southern Tagalog region (P4,832) (RP-NSCB, 1997). Halang residents had significantly higher per capita incomes than

Table 4.13. Average annual household income, per capita income and household expenses for all three communities

Community	Average annual income in pesos (US$)*	Average annual per capita income in pesos (US$)*	Average annual expenses in pesos (US$)*
Imbarasan / Himamara	P24,000 ($830)a	P5050 ($175)a	P35,000 ($1200)a
Halang	P47,000 ($1620)b	P12,450 ($430)b	P48,000 ($1660)b
Upper Magsaysay	P36,000 ($1240)ab	P6500 ($225)a	P31,000 ($1070)a

*Means followed by the same letter are not significantly different ($p > 0.05$) based on paired t-test results.

residents of the other two sites. Significant percentages of households in all three communities were living below the government established poverty line (70% of households in Imbarasan / Himamara, 59% of households in Upper Magsaysay and 21% of households in Halang). Reported expenses in both Upper Magsaysay and Imbarasan / Himamara were well below the national average for rural families of P44,400 (RP-NSCB, 1997). Halang expenses were slightly higher than average. Average expenses in Upper Magsaysay and Imbarasan / Himamara were not significantly different. However, both averages were significantly lower than average household expenses in Halang (Table 4.13).

Taken as a group, these income and expense figures supported the general observations that Halang had a much more cash based economy, while the other two communities produced more for subsistence. The added expenses and added income in Halang were also a result of the closer proximity to Manila. This proximity allowed residents to receive increased wages for off-farm labor and higher prices for their agricultural products (especially cattle). However, they also paid higher prices for purchased food such as meat and vegetables.

Local perceptions of problems and good things

The final area of between-site comparison were the problems and good things about living in each area as reported by area residents. Each area was unique; however, common themes emerged in all three areas for both problems and good things. Each area was dominated by a few common problems (Table 4.14). In Imbarasan / Himamara the most common perceived problems were the lack of an access road (98%), financial problems (46%), and problems associated with the severe dry season (22%). In contrast, drinking water (98%) was the most commonly cited problem in Halang followed by poor roads (33%) and lack of electricity (19%). In Upper Magsaysay, livelihood and food issues (68%), poor roads (66%) and financial problems (32%) were the most important.

Although the specific problems differed among the communities, some commonalities were apparent. First of all, lack of infrastructure (roads, electricity, water) was perceived as a major problem in all three communities. This was not surprising given that all three areas were marginal upland communities that lacked resources to finance major infrastructure improvements themselves and lacked the political power to obtain scarce government funds. Financial problems were important in both Imbarasan / Himamara and Upper Magsaysay but were not commonly perceived to be a problem in the much more market-based economy of

Table 4.14. Reported problems in the three communities

Problems*	Imbarsasan/Himamara (N = 63)	Halang (N = 42)	Upper Magsaysay (N = 41)
Livelihood, food	3 (5%)	3 (7%)	28 (68%)
Financial problems	29 (46%)	4 (10%)	13 (32%)
Health, drinking water	6 (10%)	41 (98%)	1 (2%)
Storms, floods	2 (3%)	2 (5%)	5 (12%)
Dry season, drought	14 (22%)	1 (2%)	0
Crop production problems (pests, irrigation)	4 (6%)	1 (2%)	3 (7%)
Crop production needs (lack of extension, seed, machinery)	2 (3%)	0	1 (2%)
Land issues	0	0	3 (7%)
Road, access	62 (98%)	14 (33%)	27 (66%)
Electricity	0	8 (19%)	0
Other	0	0	3 (7%)
None	1 (2%)	0	1 (2%)

*Survey respondents could list up to four problems

Halang. Only in Upper Magsaysay did a significant percentage of residents report food to be a problem. This was probably due to the combination of poor soils, that limited food crop yields, and the climate and access conditions that limited diversification to non-food enterprises.

Although residents reported some problems in all three communities, most people that I talked with expressed a desire to remain in their community and cited a number of good things about their areas (Table 4.15). As in the case of the problems listed above, a small number of good things were commonly cited in each location. In Imbarasan / Himamara, land ownership and control over personal and family livelihood was the most commonly cited good thing about the area (67%). Other common responses were that things were OK (48%), things were better than where we used to live (17%) and that the area was calm and quiet (16%). In contrast, Halang residents overwhelmingly cited peace and quiet (93%) as the main advantage to their location. Land ownership and control over ones own livelihood were also commonly cited (26%). In Upper Magsaysay, peace and quiet was the most commonly cited advantage (49%) followed closely by access to land and livelihood opportunities (46%). Community togetherness (32%) and low household expenses (22%) were also important.

As in the case of problems, although the specific distribution of advantages differed between communities, some common characteristics emerged. In all three communities, access and control over land and livelihood opportunities and peace and

Table 4.15. Good things in the three communities

Good things*	Imbarsasan/Himamara (N = 63)	Halang (N = 42)	Upper Magsaysay (N = 41)
Calm, quiet	10 (16%)	39 (93%)	20 (49%)
Fresh air, fresh water	5 (8%)	1 (2%)	8 (20%)
Comfortable life	0	5 (12%)	1 (2%)
OK	30 (48%)	0	9 (22%)
Own land, livelihood	42 (67%)	11 (26%)	19 (46%)
Low expenses	4 (6%)	3 (7%)	10 (24%)
Family	6 (10%)	0	2 (5%)
Togetherness, sense of community	1 (2%)	2 (5%)	13 (32%)
Far from sickness	0	0	2 (5%)
Better than where we lived before	11 (17%)	0	0
Other	0	0	4 (10%)

*Survey respondents could list up to 4 good things quiet were two of the most commonly cited advantages of life in the community. Since all three communities were primarily settled by residents looking for land to farm, the first perceived advantage was not at all surprising. The second perceived advantage, peace and quiet, may have been a reflection of self-selection among these populations. The original migrants had a choice of migrating to another rural area or migrating to the city. Those who chose to stay in farming were more likely to be people who valued the attributes of rural life like peace and quiet. In addition, the responses were provide by people who continued to reside in the areas. Former residents who may have been drawn to the faster, busier lifestyle of urban areas had already left.

Two other interesting points can be observed in the table. First, residents of Imbarasan / Himamara were the only residents to directly (and favorably) compare their current situation to the one they left behind. I lacked a good explanation for the lack of this response in the other communities. Second, family and community togetherness were cited as advantages only in Upper Magsaysay and Imbarasan / Himamara, not in the much more closely knit community of Halang. I think that this may have been because Halang residents take this togetherness as a given characteristic of their community and think of it as nothing special. Therefore, they did not give it as a survey response. In informal discussions in Halang, residents were quick to point of the virtues of their community togetherness and, in fact, worried most about this being lost as a result of changes in the area.

Chapter 5
Sustainability assessment using agroecosystems analysis

In this chapter, I used the agroecosystem analysis (AEA) framework to assess the relative sustainability of the community and household livelihood systems described and discussed in the previous chapter. The chapter is divided into major sections. In the first section, I used the procedures described in the methods chapter (Chapter 3) to assess and combine the agroecosystem properties at the community level for each of the three study communities. In the second section, I followed the same process for the 20 individual example household livelihood system. The third section of the chapter contains further analysis and discussion of the results presented in the first two sections.

Community level

In this section of the chapter, I present the results of the sustainability assessment based on the agroecosystem properties for the three study communities. The section is divided into two parts. First, I assessed the nine agroecosystem properties: productivity, stability, maintenance, resilience, equitability, autonomy, soilidarity, diversity and adaptability, individually. I then used three methods to combine the ratings from each of the individual assessments in order to develop three overall sustainability ratings.

Individual properties

Productivity

The first individual property that I assessed was productivity. As discussed in the methods chapter, I used three variables to assess the productivity of each of the three study communities. They were: total income, per capita income and annual crop yields. These three variables were the basis for three measures: total income as compared with national averages, per capita income as compared with the national poverty line and annual crop yields as compared with national averages.

Total household income

The first measure assessed was total household income. Because this was a community-level assessment, I used the community mean income as the variable of interest and compared it to the national mean rural income level of 53,500 pesos (RP-NSCB, 1997) (Table 5.1). As was mentioned in the previous chapter and is apparent again from Table 5.1, there were significant differences in average income between the three sites. These differences were reflected in this component of the productivity ratings. Although all three communities had average income levels below the national averages, income in Halang was within the criteria (75%-125% of the national average) discussed in the methods chapter to merit a rating of moderate. Income levels in both Imbarasan / Himamara and Upper Magsaysay did not meet the 75% threshold and so were rated low.

Table 5.1. Total household income component of the community level productivity rating

Community	Average annual income (Pesos)	Percentage of national average(P53,500)	Rating
Imb/Him	24,000	44.9	Low
Halang	47,000	87.9	Moderate
Up Mag	35,600	66.5	Low

Per capita income

The second productivity measure that I used was a comparison between community per capita income levels and national per capita income at the poverty threshold, the per capita income believed necessary to meet basic subsistence needs. For 1997, this value was set by the government at 8,885 pesos (RP-NSCB 1997). Per capita income for the three communities was calculated as the total community income divided by the total number of residents. This provided a measure of the total amount of money available in the community across household boundaries. Per capita income in Imbarasan / Himamara and in Upper Magsaysay was well below the national poverty threshold while the per capita income in Halang was approximately 15% over the poverty level (Table 5.2).

Crop yields compared to national averages

The third measure that I used to assess system productivity was the ratio of the average reported yields for major crops in the community and the national average yields for these crops. The results are presented in Table 5.3. Average yields of nearly

Table 5.2. Per capita income component of the community level productivity rating

Community	Per capita income (Pesos)	Percent of poverty threshold (P8,885)	Rating
Imb / Him	5,257	59%	Low
Halang	10,170	114%	Moderate
Up Mag	6,735	76%	Low

all crops in the three study were below the national averages and in some cases (e.g. cassava in Imbarasan / Himamara, upland rice in Upper Magsaysay) were well below the national averages. The exceptions to this were *palay bukid* in Imbarasan / Himamara (123% of national average), *palay kaingin* in Halang (110%) and peanut in Halang (123%). Combining the individual crop ratings within communities resulted in an overall productivity component rating of low for Imbarasan / Himamara, moderate for Halang, and low for Upper Magsaysay.

Overall

I used the additive method described in the methods chapter to combined the three measures of productivity to develop an overall productivity assessment. The overall community productivity ratings (Table 5.4) reflected the values of the measures discussed above and were low for both Imbarasan / Himamara and Upper Magsaysay. Halang had a moderate value of productivity. Even though both Imbarasan / Himamara and Upper Magsaysay were rated low, yields as compared to national averages were higher in Imbarasan / Himamara. This was largely due to the relatively good yields of *palay bukid* in that community. These yields, in turn, may have been a

Table 5.3. Yield/average ratio component of the community level productivity rating

Community	Crop	Average	Nat avg*	Percent	Rating	Overall rating
Imb/Him	*Palay bukid*	3500 kg/ha	2850	123	Moderate	Low
	Maize	700 kg/ha	1520	46	Low	
	Cassava	1750 kg/ha	8590	20	Low	
	Mung bean	525 kg/ha	750	70	Low	
Halang	*Palay kaingin*	1100 kg/ha	1000	110	Moderate	Moderate
	Maize	1175 kg/ha	1520	77	Moderate	
	Taro	2000 kg/ha	3600	56	Low	
	Peanut	1025 kg/ha	760	135	High	
Up Mag	*Palay kaingin*	370 kg/ha	1000	37	Low	Low
	Cassava	3750 kg/ha	8590	44	Low	
	Ginger	520 kg/ha	527	99	Moderate	

**Palay bukid*, maize, peanut and cassava yields from RP-NSCB (1997), upland rice yields from Pandey (1996), taro yields from PCARR (1977), ginger yields are the Quezon provincial average from RP-NSO (1990).

reflection of both a favorable environment for *palay bukid* and the increased use of chemical fertilizers and pesticides in *palay bukid* production in the community.

Table 5.4. Overall community level productivity assessment

Community	Total income	Per capita income	Yield/Nat. Avg.	Overall rating
Imb/Him	Low	Low	Low	Low
Halang	Moderate	Moderate	Moderate	Moderate
Up Mag	Low	Low	Low	Low

Stability

The second agroecosystem property that I considered is stability. I used four criteria to assess stability at the community level: responses to two survey questions related to crop yield stability, comments from informal interviews related to system stability or instability, and my personal assessment of livelihood system stability in the three study communities. These criteria were combined using the same additive index method described previously for productivity. Based on the four criteria, I developed the ratings shown in Table 5.5. Livelihood system stability in Imbarasan / Himamara and in Halang was rated moderate. This was largely due to the compensatory effect of the mix of activities in the communities. Even though some individual system components in the community had relatively low levels of stability, overall, the system seems to have a moderate level of stability. In Upper Magsaysay, the extreme fluctuations in most enterprises did not show this compensatory behavior resulting in a system stability rating of low.

Table 5.5. Stability assessment criteria and overall rating

Community	Yield stability major crop #1 (Survey)	Yield stability major crop #2 (Survey)	Rating from interviews	Researcher rating	Overall Rating
Imb/Him	Moderate	Moderate	Moderate	High	Moderate
Halang	Moderate	Moderate	Moderate	Moderate	Moderate
Up Mag	Moderate	Moderate	Low	Moderate	Moderate

Maintenance

Maintenance, the response of the livelihood system to a regular stress, was the third agroecosystem property included in the sustainability assessment. As in the case of stability, four measures were used: responses to two survey questions, comments from informal interviews, and my personal assessment. These were combined using the same method as the previous two properties. From these indicators, I developed the ratings shown in Table 5.6. Halang was rated high. Imbarasan / Himamara was rated moderate. Upper Magsaysay was rated low. In the first two communities, residents were aware of ongoing land degradation (e.g. erosion, soil fertility loss) and I saw evidence of these processes. However, these negative indicators were partially offset by factors that contribute to increased maintenance levels including the highly weatherable parent material and leguminous tree-based fallows in Halang and the long fallow periods and increasing use of tree crops in Imbarasan / Himamara. The primary difference between the two sites was that, based on survey responses, a greater percentage of Halang residents than Imbarasan / Himamara residents believed that their system was maintaining productivity. In Upper Magsaysay, the main money-making activity, timber harvest, had a low maintenance level since it was based on a resource that is declining much more quickly than the natural regeneration rate. Significant soil fertility decline and severe erosion were also regularly observed in annual cropping system in spite of the use of long fallow periods. The combination of these factors resulted in a rating of low for Upper Magsaysay.

Table 5.6. Maintenance assessment criteria and overall rating

Community	Yield maintenance major crop #1 (Survey)	Yield maintenance major crop #2 (Survey)	Rating from interviews	Researcher rating	Overall Rating
Imb / Him	Low	Moderate	Moderate	Moderate	Moderate
Halang	High	High	Moderate	Moderate	Moderate
Up Mag	Moderate	Moderate	Low	Low	Low

Resilience

The fourth agroecosystem property considered in this analysis is resilience. This was the response of the livelihood system to unusual severe shocks. As in the case of the previous two properties, I used four indicators. The first two were based on survey responses, the third on informal interview comments and the fourth on my personal opinion. These four individual ratings were combined as above to develop an overall rating (Table 5.7). In all three cases, community resilience was rated high. This makes intuitive sense given that I set out to select study communities made up of migrants who had lived there for a significant amount of time. Simply by still being there, they have shown that their systems are resilient.

Table 5.7. Resilience assessment criteria and overall rating

Community	Yield resilience major crop #1 (Survey)	Yield resilience major crop #2 (Survey)	Rating from interviews	Researcher rating	Overall Rating
Imb/Him	High	High	High	High	High
Halang	High	High	High	Moderate	High
Up Mag	High	High	Moderate	High	High

Equitability

The fifth agroecosystem property that I assessed was equitability. I used three criteria to assess the equitability of the three study communities: land distribution, distribution of total income and distribution of per capita income. As outlined in the methods chapter, I measured the equitability of land distribution and total income distribution using the Gini coefficient. I used the ratio of the per capita income of the top 20% of households to that of the bottom 20% of households as a measure of the equitability of the distribution of per capita income.

As shown in Table 5.8, both Imbarasan / Himamara and Halang had an overall equitability ranking of moderate while Upper Magsaysay has a rating of low. Even though Imbarasan / Himamara and Halang both rated moderate, they showed a different distribution of the sub-components of overall equitability. In Halang, all three measures were moderate while in Imbarasan / Himamara, the land distribution was more highly equitable while the income measures were less equitable.

Table 5.8. Equitability ratings for study communities

Community	Land (Gini)	Total income (Gini)	Per capita income (Richest 20%/Poorest 20%)	Overall rating
Imbarasan/Himamara	0.30 High	0.46 Low	15.2 Low	Mod
Halang	0.45 Mod	0.39 Mod	9.2 Mod	Mod
Upper Magsaysay	0.46 Low	0.51 Low	20.8 Low	Low

Autonomy

The sixth agroecosystem property considered was autonomy. Given the data I had available, I was unable to develop specific measures for this property at the community level. Therefore, these ratings were based on my own personal assessments. I rated autonomy in Imbarasan / Himamara as moderate. Many community residents were very self-sufficient especially with respect to basic food needs. In addition, outside inputs to agricultural production were moderate to low, chemical fertilizers and pesticides were only used in paddy rice production and even then not by all residents. However, the community had significant and increasing connections to the larger system. Agricultural products are sold outside the community as was labor. The cash generated by these activities was used for expenses such as household needs (coffee, sugar, salt, clothing, etc.) and schooling that came from outside the study community. Given the increasing cultivation of cash annuals (garlic) and the potential for increased perennial cultivation, these inter-connections with the outside are likely to increase.

In contrast, Halang had a low level of autonomy. Most residents did not produce sufficient food for home consumption. As a consequence, the community was dependent on the sale of agricultural products (taro, peanut), livestock and charcoal to earn the cash necessary to purchase food, household needs, and to meet other expenses such as education. In addition, the taro component of their annual crop system was based on the use of significant chemical fertilizer inputs that must be purchased from outside the community.

The level of autonomy in Upper Magsaysay was not as low as the level in Halang but also was rated as low overall. A significant number of residents in the community were unable to meet even their basic subsistence food needs from their holdings. They were forced to sell agricultural products and more importantly forest products (timber, rattan) outside the community to earn the cash necessary to purchase food and other household needs and to meet other expenses such as schooling.

Solidarity

The seventh agroecosystem property considered in this analysis was solidarity. As in the case of autonomy, I was unable to develop specific measures of community solidarity and so have based this assessment on my personal opinion informed by what I learned though conversations with area residents and personal observations. Solidarity in Imbarasan / Himamara was low. Residents did not talk of a community spirit or community ties and there was little evidence of community-based practices. Most exchange labor arrangements (typically cited as evidence of community cohesion) that I was told existed in the past had been replaced by monetary compensation. I believe that the composition of the community led it to have a generally low level of solidarity throughout its history. Imbarasan / Himamara was made up of migrants from several different areas. Only a few families migrated with relatives or to join relatives. Therefore, the community never had the strong family and socio-linguistic connections that tie other areas together.

Halang stood in direct contrast to Imbarasan / Himamara and was rated high for solidarity. Virtually all Halang residents were members (by blood or marriage) of one of the four families who originally settled the area from Calaca, Batangas. They valued and had maintained these kinship and friendship ties throughout the past nearly 30 years that they have lived in the area. Although I saw little evidence of cooperative activities, residents commonly spoke of community cohesion and solidarity in informal interviews and casual conversations.

Solidarity in Upper Magsaysay was also rated high. This was primarily because community togetherness and solidarity was a common theme in informal interviews and conversations with residents. Historically, this togetherness may have resulted from the settlement pattern. Unlike the other two communities, Upper Magsaysay was settled largely by local residents from further down the hill who had slowly moved further into the mountains. Therefore, they had been able to maintain ties with others who had moved into the community (who they may have known before in other communities) and with other parts of the larger community (e.g. lower parts of Barangay Magsaysay) where they still had family and friends.

Diversity

The eighth property that I assessed was diversity. I assessed diversity using three measures: the species abundance in the community, the average number of guilds, and the average number of income sources. These values were based on survey responses. These measures were rated separately using the procedure discussed in the methods chapter. The three measures were then combined using the additive index method to overall community rating (Table 5.9).

All three sites received an overall rating of moderate. However some differences between the three sites were apparent. In general, Upper Magsaysay has the lowest level of diversity across all measures. Halang had higher levels than Imbarasan / Himamara for three measures (animals, perennials, income sources) while the relationship was reversed for the other two (crops, guilds).

Table 5.9. Community level diversity assessment criteria and overall rating

Community	Species				Guilds	Income sources	Overall Rating
	Annual	Animal	Perennial	Overall			
Imbarasan / Himamara	4.4 Mod	2.4 Low	5.7 Mod	Mod	8.5 Moderate	2.3 Moderate	Moderate
Halang	3.9 Mod	3.0 Mod	7.7 Mod	Mod	7.7 Moderate	3.1 Moderate	Moderate
Upper Magsaysay	2.6 Low	1.8 Low	6.3 Mod	Low	6.6 Moderate	1.9 Moderate	Moderate

Adaptability

The ninth and final agroecosystem property was adaptability. As in the case of autonomy and solidarity, I was unable to develop a set of measures for this property. Therefore, I based this rating on my personal opinion informed by discussions with local residents and personal observations. Overall, adaptability in Halang was rated high. Many residents had shown the ability to adopt new crops and new management systems in response to changes in both their physical and socio-economic environment. The principal evidence of this was the widespread adoption of taro cultivation and cattle raising in the area once soil fertility levels became too low to support a livelihood system based on grain crops.

Adaptability was also high in Imbarasan / Himamara. Residents in the area had also adapted their management system to changing environmental and socio-economic conditions although these changes had not been as significant as they have been in Halang. Another factor contributing to the high adaptability rating in Imbarasan / Himamara was interviews with several residents where ideas of experimentation and testing of new species and management systems were discussed.

At the present time, adaptability in Upper Magsaysay was rated as moderate. Although I only found a small amount of evidence related to changes in system management over time, ideas of experimentation and testing of new varieties and management systems were brought up by some community residents in interviews and discussions. There was also evidence that a small number of residents were trying some management alternatives in the face of the collapse of the copra market which had provided a significant portion of their livelihood.

Overall assessment

Given the ratings of individual properties determined above, the next step was to determine an overall sustainability rating for each of the three sites. As discussed in the methods chapter, I found no definitive procedure for combining individual ratings into a combined index value. Therefore, I applied three of the most commonly used procedures to the sets of individual property ratings (summarized in Table 5.10) in order to develop overall sustainability ratings (Table 5.11). These three procedures were: 1. An additive index, 2. A "law of the minimum" procedure and 3. A dominant value based procedure.

Table 5.10. Agroecosystem property ratings for three communities

Site	Prod	Stab	Main	Resil	Equit	Auto	Solid	Div	Adapt
I/H	L	M	M	H	M	M	L	M	H
Hal	M	M	M	H	M	L	H	M	H
UpM	L	L	L	H	L	L	H	M	M

Table 5.11. Overall community sustainability ratings

Community	Additive index*	Law of the minimum	Dominant value**
Imbarasan / Himamara	Moderate (18)	Low	Moderate (5)
Halang	Moderate (21)	Low	Moderate-High (4)
Upper Magsaysay	Moderate (15)	Low	Low (5)

*Numbers in parentheses are the total additive index score for the site
**Numbers in parentheses are the total number of properties with the dominant value

Additive index

The first and most common way to combine a group of measures or ratings into one composite rating is to use a simple additive procedure. In this case, I assigned high ratings a value of 3, moderate ratings a value of 2 and low ratings a value of 1. Adding the nine ratings for each community produced an index with a minimum value of 9 and a maximum value of 27. In order to determine the overall ranking, I simply divided the potential index scores into three groups. An index value in the upper one-third of values (22-27) was rated as high. A value in the middle one-third (15-21) was rated moderate, and a value in the lowest one-third (9-14) was rated low.

When I applied this procedure to the analysis results (Table 5.10), all three sites were rated as moderate. However, they had significantly different index values ranging from a low of 15 in Upper Magsaysay (the lowest possible value for a moderate rating) to a high of 21 in Halang (the highest possible value for a moderate rating). Imbarasan / Himamara with a value of 18 fell in the middle of the moderate range (Table 5.11).

Law of the minimum

The second commonly used approach to combining variables into a composite variable was the law of the minimum. As discussed in the methods section, this method assigned the combination of variables the same ranking as the lowest component. In the case of all three study communities, the rating using this procedure was low (Table 5.11).

Dominant value

The third procedure that I used to assess the overall community-level sustainability was based on the dominant value of the 9 agroecosystem properties. Using this methodology, system sustainability was rated according to the most common value of the nine individual property ratings. When I applied this methodology to the analysis results, Halang was rated moderate-high since four properties were rated moderate and four were rated high. Imbarasan / Himamara was rated moderate and Upper Magsaysay was rated low (Table 5.11).

Summary

Although the three different procedures used to develop a single sustainability index from the analysis data (Table 5.10) produced different results, some general trends were apparent. First of all, all three communities rated low under the "law of the minimum" procedure. These results suggested at least two things. First of all, all three communities had some degree of unsustainability as evidenced by the presence of one or more agroecosystem properties that were rated low. However, the results also indicated that, taken by itself, the "law of the minimum" procedure did not provide any information about the differences between sites.

The other two combining procedures, the additive method and the dominant value method, provided slightly more differentiation between the three communities. However, if just the overall ratings were taken, all three communities had the same rating, moderate, when the additive index were used. However, a closer examination of the index values, revealed that Halang had the highest overall rating followed by Imbarasan / Himamara and Upper Magsaysay. Under the dominant value method, the sites were rated in the same order as with the additive method. The agreement between these two methods indicated that, based on the agroecosystem analysis properties, Halang had the highest overall sustainability rating. Imbarasan / Himamara had a slightly lower sustainability rating.

Relationships between individual properties and overall sustainability

Higher levels of productivity, maintenance and solidarity let to the higher overall sustainability rating for Halang as compared to the other two communities. The higher levels of productivity were largely due to the more intensive and market oriented management system used in the community. This intensification and market focus were much easier because Halang was located near Manila.

Imbarasan / Himamara had a moderate level of overall sustainability; lower than Halang but higher than Upper Magsaysay. In spite of having a higher level of autonomy than Halang, the low levels of productivity and solidarity led to an overall lower level of sustainability. Low productivity in Imbarasan / Himamara was a reflection of the lower intensity and more subsistence-focused management systems in the community. The low level of solidarity was because Imbarasan / Himamara was a much more diverse immigrant community than the other two communities.

Upper Magsaysay was rated considerably lower than the other two communities highlighted by low ratings in productivity, stability, maintenance, equitability and autonomy. The low levels of productivity, stability, maintenance and autonomy were related to the difficult environmental conditions in the area. It had generally poor soils and typhoons were frequent. In addition, the area was difficult to get to and local marketing opportunities were few. Residents reliance on a timber harvest for a significant percentage of their income contributed to low levels of autonomy.

Household level

The next component of the sustainability assessment is an analysis at the household level. In this section, I followed the same framework that I used for the community level and used the assessment criteria and methodologies described in the methods chapter, to assess the agroecosystem properties for the 20 example households (8 from Imbarasan / Himamara, 8 from Halang, and 4 from Upper Magsaysay). I then developed an overall sustainability rating for each household using the three methods for combining variables that I used at the community level.

Individual properties

The first part of the household sustainability analysis was an assessment of seven of the nine agroecosystem analysis properties: productivity, stability, maintenance, resilience, autonomy, diversity and adaptability. Although it is theoretically possible to assess equitability and solidarity at the household level, I did not collect information on intra-household dynamics and so did not include these variables in the household level assessment.

Productivity

The first property that I assessed at the household level was productivity. At the household level, I used five measures to define household productivity: total annual income, annual per capita income, annual income per hectare, total monetary value of harvested crops and relative crop yields based on national averages.

Total annual income

The first measure I used to assess productivity was total annual household income. I calculated the household income as a percentage of the national average for rural households of P53,500 (RP-NSCB, 1997) and used this percentage to rate household productivity as high, moderate or low (Table 5.12). As is shown in the table, there was considerably more range in the individual household values within sites than was reflected in the community average values used for the community-level assessment. Ratings on this component of productivity ranged from high to low in all three sites. Low ratings were most common in Imbarasan / Himamara (5 of 8 household) and in Upper Magsaysay (2 of 4 households) while high ratings dominated in Halang (5 of 8 households).

Annual per capita income

The second component that I used in the assessment of productivity at the household level was per capita income. As in the community-level analysis, this was compared with the national poverty threshold of P8,885 (RP-NSCB 1997). Based on this comparison, I rated households either high (if over 200% of poverty threshold), moderate (100%-200%) or low (under the poverty threshold) (Table 5.13). Only a few households had per capita incomes that rated high (1 in Imbarasan / Himamara, 2 in Halang, 1 in Upper Magsaysay). Most households (11 of 20) were rated low since they had incomes below the poverty threshold.

Table 5.12. Annual income component of household level productivity assessment

Household	Annual income (pesos)	Percent of national average (P53,500)	Rating
IH1	88,500	165	High
IH2	42,500	79	Moderate
IH3	7,200	13	Low
IH4	52,000	97	Moderate
IH5	16,250	30	Low
IH6	37,000	69	Low
IH7	37,200	70	Low
IH8	10,000	19	Low
H1	64,250	120	High
H2	106,900	200	High
H3	78,800	147	High
H4	20,950	39	Low
H5	23,800	44	Low
H6	68,000	127	High
H7	137,500	257	High
H8	65,000	121	Moderate
UM1	46,000	86	Moderate
UM2	15,800	30	Low
UM3	84,000	157	High
UM4	34,000	64	Low

Table 5.13. Per capita income component of household level productivity assessment

Household	Income (pesos)	Family size	Per capita income	Percent of poverty threshold (P8,885)	Rating
IH1	88,500	7	12,643	142	Moderate
IH2	42,500	6	7,083	80	Low
IH3	7,200	10	720	8	Low
IH4	52,000	4	13,000	146	Moderate
IH5	16,250	5	3,250	37	Low
IH6	37,000	2	18,500	208	High
IH7	37,200	9	4,133	47	Low
IH8	10,000	1	10,000	113	Moderate
H1	64,250	9	7,139	80	Low
H2	106,900	6	17,483	197	Moderate
H3	78,800	9	8,756	99	Low
H4	20,950	2	10,475	118	Moderate
H5	23,800	7	3,400	38	Low
H6	68,000	11	6,182	70	Low
H7	137,500	3	45,833	515	High
H8	65,000	3	21,667	243	High
UM1	46,000	6	7,667	86	Low
UM2	15,800	3	5,267	59	Low
UM3	84,000	4	21,000	236	High
UM4	34,000	6	5,667	64	Low

Total income per hectare

The third measure that I used for the household level productivity assessment was the total income per hectare. I then computed the value of the household level as a percentage of the regional average of P22,200/ha (calculated from RP-NSCB, 1997 and DA, 1994). I used this percentage value to rate each of the households (Table 5.14). As was apparent for other productivity measures, this measure showed considerable range within two of the three communities, Imbarasan / Himamara and Halang. Because of the large land holdings and extensive management practices common in Upper Magsaysay, all four households there were rated low.

Total monetary value of annual crops

The fourth measure that I used to assess productivity was the total monetary value of annual crops. I used this variable in an attempt to include household production primarily for family use that was not included in the income measures. I computed this measure as a percentage of the national average rural household income (P53,500) and used these percentages as the basis for household ratings (Table 5.15). As shown in the table, all households in Upper Magsaysay and most households in Halang and in Imbarasan / Himamara (4 of 8) had ratings of low. This suggests that, at least in 1996, crop production was relatively low and was probably only a major source of income for a small number of households.

Table 5.14. Income per hectare component of household level productivity assessment

Household	Annual Income	Land size (hectares)	Income per hectare	Percent of regional average	Rating
IH1	88,500	5	17,700	80	Moderate
IH2	42,500	2.1	20,238	91	Moderate
IH3	7,200	2.5	2,880	13	Low
IH4	52,000	2	26,000	117	Moderate
IH5	16,250	3	5,417	24	Low
IH6	37,000	7	5,286	24	Low
IH7	37,200	3	12,400	56	Low
IH8	10,000	1	10,000	45	Low
H1	64,250	2	32,125	145	High
H2	106,900	3	35,633	161	High
H3	78,800	6	13,133	59	Low
H4	20,950	3	6,983	31	Low
H5	23,800	1	23,800	107	Moderate
H6	68,000	0.25	272,000	1225	High
H7	137,500	5	27,500	124	Moderate
H8	65,000	15	4,333	20	Low
UM1	46,000	30	1533	7	Low
UM2	15,800	20	790	4	Low
UM3	84,000	7.25	11,586	52	Low
UM4	34,000	5	6,800	31	Low

Table 5.15. Monetary value of annual crops component of household level productivity assessment

Household	Total value (pesos)	Percent of national average household income	Overall rating
IH1	195,000	364	High
IH2	57,925	108	Moderate
IH3	11,325	21	Low
IH4	96,975	181	High
IH5	4480	8	Low
IH6	n/a	n/a	n/a
IH7	37,750	71	Low
IH8	19,500	36	Low
H1	13,800	26	Low
H2	14,350	27	Low
H3	25,375	47	Low
H4	8,137	15	Low
H5	20,450	38	Low
H6	n/a	n/a	n/a
H7	101,700	190	High
H8	n/a	n/a	n/a
UM1	5,800	11	Low
UM2	4,950	9	Low
UM3	19,300	36	Low
UM4	4,325	8	Low

Crop yields based on national or provincial averages

The fifth productivity measure that I applied was an assessment of crop yields as compared with national or provincial averages. I computed the value of this measure using the two most important crop species reported by the household on the survey questionnaire or in informal interviews. I computed values for each crop as a percentage of the national or provincial average yields. I took the average of the two percentages and used this a the basis for the overall rating (Table 5.16). I could not assess ratings for two households in Halang since they did not report cultivation of annual crops or fruit tree species.

The household level information generally paralleled the information presented earlier for the community level. Crop yields were generally below average in Imbarasan / Himamara and in Upper Magsaysay and above average in Halang. However, one household in Imbarasan / Himamara and one in Upper Magsaysay were rated high on the strength of their production of bitter melon and ginger respectively. In addition, two households in Halang did not follow the general trend for that community and received low ratings.

Overall productivity assessment

I combined the individual measures of productivity using an additive index as described in the methods section (Table 5.17). The ratings in the table generally paralleled the community-level ratings discussed previously. Halang households

Table 5.16. Relative annual crop yields based on national averages component of household level productivity assessment

Hshld	Crop #1	Yield kg/ha	Nat. avg.*	%	Crop #2	Yield kg/ha	Nat. avg.*	%	Overall Rating
IH1	Rice (l)	3000	2850	105	Mung bean	300	750	40	Low
IH2	Rice (l)	2667	2850	94	Garlic	1500	2730	55	Low
IH3	Rice (l)	3000	2850	105	Maize	500	1520	33	Low
IH4	Rice (l)	2500	2880	87	Bitter melon	4800	2763	174	High
IH5	Maize	75	1520	5	Banana	1000	9500	11	Low
IH6	Banana	7800	9500	82	n/a				Moderate
IH7	Rice (l)	3000	2850	105	Mung bean	600	750	80	Moderate
IH8	Maize	1500	1520	99	n/a				Moderate
H1	Rice (u)	1750	1000	175	Taro	1200	3600	33	Moderate
H2	Rice (u)	800	1000	80	Taro	1000	3600	28	Low
H3	Peanut	1400	760	184	Taro	3000	3600	83	High
H4	Rice (l)	2400	2850	84	Maize	4600	1520	303	High
H5	Taro	6800	3600	188	Maize	2050	1520	135	High
H6	None				n/a				n/a
H7	Maize	1800	1520	118	Rice (l)	5000	2850	175	High
H8	None				n/a				n/a
UM1	Rice (u)	200	1000	20	Ginger	500	527	95	Low
UM2	Ginger	510	527	97	Rice (u)	300	1000	30	Low
UM3	Rice (l)	2000	2850	70	Coconut**	1000	2500	40	Low
UM4	Rice (u)	200	1000	20	Ginger	1500	527	285	High

*Coconut and bitter melon are provincial averages from Quezon province data (RP-NSO, 1990); taro values are national averages from PCARR (1977); upland rice values are national averages from Pandey (1996); all other crops are national averages of 1994-1996 values from RP-NSCB (1997).
**Coconut yield is in nuts per hectare.

Table 5.17. Overall household level productivity assessment

Household	Total income	Per capita income	Income per hectare	Peso value of annual crops	Yield/ Nat avg	Overall rating (score)
IH1	High	Mod	Mod	High	Low	Moderate (10)
IH2	High	Low	Mod	Mod	Low	Moderate (9)
IH3	Low	Low	Low	Low	Low	Low (5)
IH4	Mod	Mod	Mod	High	High	High (12)
IH5	Low	Low	Low	Low	Low	Low (5)
IH6	High	High	Low	n/a	Mod	Moderate (9)
IH7	High	Low	Low	Low	Mod	Low (8)
IH8	Low	Mod	Low	Low	Mod	Low (7)
H1	High	Low	High	Low	Mod	Moderate (10)
H2	High	Mod	High	Low	Low	Moderate (9)
H3	High	Low	Low	Low	High	Moderate (9)
H4	Low	Mod	Low	Low	High	Low (8)
H5	Low	Low	Mod	Low	High	Moderate (8)
H6	High	Low	High	n/a	n/a	Moderate (7)
H7	High	High	Mod	High	High	High (14)
H8	High	High	Low	n/a	n/a	Moderate (7)
UM1	High	Low	Low	Low	Low	Low (7)
UM2	Low	Low	Low	Low	Low	Low (5)
UM3	High	High	Low	Low	Low	Moderate (9)
UM4	Mod	Low	Low	Low	High	Low (8)

generally had the highest productivity with five of the eight example households rated moderate, one rated high and only two rated low. Household productivity was lower in Imbarasan / Himamara with four households rated low and three rated moderate. One household in Imbarasan / Himamara was rated high. As was the case at the community level, household level productivity in Upper Magsaysay was the lowest of the three sites with three of four households rated low and only one rated moderate.

Stability

The second agroecosystem property that I assessed at the household level was stability. As noted in the methods chapter, stability would best assessed with time-series or historical data. Since I had neither of these, I used a three measures. Two were based on survey questions and the third on my personal assessment informed by residents comments. These three measures were combined as an additive index using the procedure outlined in the methods chapter (Table 5.18).

Households were very consistent in their responses to the survey questions that related to stability. As a consequence, the stability ratings were dominated by moderate ratings for both survey questions and moderate ratings for overall stability. This result made intuitive sense given that most households had resided in the communities for many years or were the children of long term residents. Consequently, they were likely to have developed reasonably stable systems or, in the case of children, to have adopted the relatively stable systems developed by their parents.

Table 5.18. Household level stability rating

Household	Yield stability for major crop #1 (Survey)	Yield stability for major crop #2 (Survey)	Researcher Assessment	Rating
IH1	Low	Moderate	High	Moderate (6)
IH2	Moderate	Moderate	Moderate	Moderate (6)
IH3	Moderate	Moderate	Moderate	Moderate (6)
IH4	Low	Moderate	Moderate	Moderate (5)
IH5	Moderate	Moderate	Low	Moderate (5)
IH6	Moderate	Moderate	High	Moderate (7)
IH7	Moderate	n/a	High	Moderate (5)
IH8	n/a	n/a	High	High (3)
H1	Moderate	Moderate	Moderate	Moderate (6)
H2	Moderate	Moderate	Moderate	Moderate (6)
H3	Moderate	Moderate	High	Moderate (7)
H4	Moderate	Moderate	High	Moderate (7)
H5	Moderate	Moderate	Low	Moderate (5)
H6	Moderate	n/a	Low	Moderate (3)
H7	Moderate	Moderate	High	Moderate (7)
H8	n/a	n/a	High	High (3)
UM1	Low	High	Low	Moderate (5)
UM2	Moderate	Moderate	Low	Moderate (5)
UM3	Moderate	Moderate	Moderate	Moderate (6)
UM4	Moderate	Moderate	Low	Moderate (5)

Maintenance

The third agroecosystem property that I assessed at the household level was maintenance. As noted in the methods chapter, maintenance is best assessed with time-series or historical data. Since I had neither of these, I used an index composed of four components: survey question responses, erosion risk, nitrogen fixing species in the rotation and researcher assessment. Details of how the index component values were calculated and how the overall maintenance level was assessed were discussed in the methods section. Index values for each component and the overall maintenance assessment are shown in Table 5.19.

Five households (IH2, IH 6, IH7, H4 and H8) were rated high. These households can be divided into two groups. One group (IH6, IH7 and H8) used management systems based on perennial crops (bananas, melina, and leuceana for charcoal respectively). All of these systems were only extracting a low percentage of the total productivity from the land and used methods that did not cause significant soil disturbance. The timber-based system used by household IH7 has the potential for significant maintenance-reducing activities at harvest but these can be avoided with appropriate harvest techniques. The remaining two households with high maintenance ratings (IH2 and H4) did not focus on perennial species, although it was a component of both systems. Their high ratings were driven by relative land abundance (H4) and cultivation of flat land (IH2). Both households also made use of nitrogen fixing species.

Table 5.19. Household level maintenance ratings

Household	Survey responses	Erosion risk	Nitrogen fixer	Researcher	Overall rating
IH1	-2	2	1	2	Moderate (3)
IH2	0	2	1	2	High (5)
IH3	0	1	1	2	Moderate (4)
IH4	-2	2	1	1	Low (2)
IH5	0	1	0	1	Low (2)
IH6	0	2	0	3	High 5
IH7	0	2	1	3	High (6)
IH8	n/a	0	0	3	Moderate (3)
H1	0	1	1	2	Moderate (4)
H2	0	1	1	2	Moderate (4)
H3	0	0	1	2	Moderate (3)
H4	0	1	1	3	High (5)
H5	0	0	1	1	Low (2)
H6	n/a	0	0	1	Low (1)
H7	0	1	1	2	Moderate (4)
H8	n/a	2	1	3	High (6)
UM1	0	1	0	1	Low (2)
UM2	0	1	0	1	Low (2)
UM3	0	1	0	1	Low (2)
UM4	0	1	0	1	Low (2)

Of the remaining households, 7 were rated moderate and 8 were rated low. The primary differences between these two groups were: the quality of available land, households rated low had access to steeper land with the corresponding greater risk of erosion; presence or absence of a nitrogen fixing species in the management system; and other indicators of relatively low maintenance, such as farmer reports of rapid fertility decline, that I included in my personal assessment.

Resilience

The fourth agroecosystem property that I assessed at the household level was resilience. As noted in the methods chapter, resilience is best assessed with time-series or historical data. Since I had neither of these, I used a three component index based on two survey questions and my personal assessment informed by residents comments. Details of the index were provided in the methods chapter. Based on index values, households were rated high, moderate or low. Two index components (the survey questions) were not available for three households (IH8, H6 and H8). Consequently, the overall rating for these households was based only on the researcher assessment (Table 5.20).

Because of the near homogeneity of example household responses to the survey questions, household stability ratings were highly dependent on my personal assessments. I used three primary criteria as the basis for my assessments. The first was comments made by residents related to the resilience of their system. Since residents were reluctant to comment on these issues, I gave the available comments

Table 5.20. Household level resilience rating

Household	Yield resilience for major crop #1 (survey)	Yield resilience for major crop #2 (survey)	Researcher	Overall rating
IH1	3	3	High (3)	High (9)
IH2	3	3	High (3)	High (9)
IH3	3	3	High (3)	High (9)
IH4	0	3	High (3)	Moderate (6)
IH5	3	3	Mod (2)	High (8)
IH6	3	3	High (3)	High (9)
IH7	3	3	High (3)	High (9)
IH8	n/a	n/a	High (3)	High (3)
H1	3	3	Mod (3)	High (8)
H2	3	3	Mod (3)	High (8)
H3	3	3	High (3)	High (9)
H4	3	3	High (3)	High (9)
H5	3	3	Mod (2)	High (8)
H6	n/a	n/a	Mod (2)	Mod (2)
H7	3	3	High (3)	High (9)
H8	n/a	n/a	High (3)	High (3)
UM1	3	3	Mod (2)	High (8)
UM2	3	3	Mod (2)	High (8)
UM3	3	3	High (3)	High (9)
UM4	3	3	Mod (2)	High (8)

considerable weight. The second component of my personal rating was the presence or absence of resilience-promoting management system components. These include irrigation, perennial species and livestock. The third criteria that I used was my personal impressions of the household system.

Because most households reported considerable system resilience in their survey responses, the vast majority of households (19 of 20) received a high rating for resilience. The only households that did not receive a high rating were households IH4 and H6; both were rated moderate. The reasons for these moderate ratings differed between the two households. Household IH4, whose system was primarily based on vegetable cultivation, was the only household to report significant fluctuations in crop yields based on sharp changes in factors outside the system. Household H6 was assigned a rating of moderate because they did not have land resources. Even though they had been able to survive to this point, they had few resources to fall back on if a major shock were to hit their livelihood system.

Given the criteria that I used to select the study communities and example households, the high resilience ratings were not unexpected. Residents who settled in these communities and were still living there many years later had developed systems that are resilient, at least in the face of the shocks of the past 20-30 years. This data provided a general indication that systems are likely to be resilient in the future; however, it was possible that the resilience of these management systems has not been tested by stronger and less common shocks like a one-in-one-hundred-year hurricane.

Autonomy

The fifth agroecosystem property used in this analysis was autonomy. In order to develop an autonomy rating for each example household, I used four measures: the percentage of total income derived from off-farm sources, the ratio of species used for sale vs species used for subsistence, the level of rice self-sufficiency and the use of external inputs including fertilizer, pesticides, labor and credit. These four measures were combined using the additive index method that was described in the methods section to determine an overall autonomy ranking (Table 5.21).

All households in Halang and Upper Magsaysay rated either low or moderate for autonomy. This was, in part, a reflection of the need for most households in these two communities to buy rice for home consumption. In contrast, there was considerable variation in autonomy ranking within Imbarasan / Himamara with two households rated low, two rated high and four rated moderate.

Diversity

The sixth agroecosystem property assessed at the household level was diversity. I used the same set of criteria described earlier during the discussion of community-level diversity assessment: species abundance, number of guilds and number of income sources. I rated households on each of the criteria and then combined the ratings into an additive index in order to determine the overall rankings for each household (Table 5.22).

Table 5.21. Household level autonomy rating

Household	Percent off-farm income	Market / subsistence	Rice	Inputs	Overall rating
IH1	H (0)	M (10/12)	H	L (4)	Moderate (9)
IH2	H (18)	H (2/5)	H	L (4)	High (10)
IH3	H (0)	M (5/9)	M	L (4)	Moderate (8)
IH4	H (0)	M (14/13)	H	L (3)	Moderate (9)
IH5	L (69)	M (7/8)	L	M (2)	Low (6)
IH6	H (0)	M (8/7)	L	H (1)	Moderate (9)
IH7	L (68)	M (est 1:1)	M	L (3)	Low (6)
IH8	H (0)	H (0/4)	M	H (1)	High (11)
H1	M (53)	H (2/9)	L	M (2)	Moderate (8)
H2	M (34)	M (8/11)	L	M (2)	Moderate (7)
H3	M (38)	M (8/11)	L	L (3)	Low (6)
H4	H (8)	M (8/9)	L	H (1)	Moderate (9)
H5	H (28)	M (9/13)	L	L (3)	Moderate (7)
H6	L (100)	M (2/4)	L	H (1)	Moderate (7)
H7	H (0)	M (10/10)	H	L (3)	Moderate (9)
H8	M (50)	L (4/0)	L	M (2)	Low (6)
UM1	L (78)	L (6/3)	L	H (1)	Low (6)
UM2	M (34)	L (11/5)	L	H (0)	Moderate (7)
UM3	L (71)	L (11/5)	M	H (1)	Moderate (7)
UM4	L (91)	L (7/2)	L	H (1)	Low (6)

Table 5.22. Household level diversity assessment criteria and overall rating

Household	Species				Guilds	Income sources	Overall Rating
	Annual	Animal	Perennial	Overall			
IH1	7 H	3 M	7 M	M	9 M	5 H	Mod (7)
IH2	4 M	2 L	5 M	M	10 H	4 H	High (8)
IH3	5 M	3 M	5 M	M	10 H	2 L	Mod (6)
IH4	9 H	3 M	8 M	M	9 M	4 H	Mod (7)
IH5	3 M	1 L	5 M	M	6 M	2 L	Mod (5)
IH6	3 M	1 L	10 M	M	7 M	5 H	Mod (7)
IH7	3 M	2 L	5 M	M	9 M	2 L	Mod (5)
IH8	1 L	0 L	3 L	L	3 L	1 L	Low (3)
H1	5 M	2 L	8 M	M	8 M	3 M	Mod (6)
H2	5 M	4 M	10 M	M	11 H	5 H	High (8)
H3	5 M	4 M	10 M	M	9 M	4 H	Mod (6)
H4	5 M	3 M	12 H	M	10 H	3 M	Mod (7)
H5	5 M	4 M	10 M	M	9 M	4 H	Mod (7)
H6	0 L	2 L	5 M	L	3 L	3 M	Low (4)
H7	5 M	3 M	11 H	M	10 H	4 H	High (8)
H8	0 L	2 L	7 M	L	4 L	3 M	Low (4)
UM1	2 L	2 L	7 M	L	8 M	2 L	Low (4)
UM2	4 M	2 L	9 M	M	7 M	2 L	Mod (5)
UM3	3 M	3 M	9 M	M	7 M	2 L	Mod (5)
UM4	4 M	2 L	6 M	M	7 M	3 M	Mod (6)

As was the case at the community level, most households were rated moderate for diversity. However, some insights were gained by looking at the small number of households with either high or low diversity. The households with high diversity (IH2, H2, H7) were all characterized by mixed management systems. All had a high number of guilds (types of activities) and a high number of income sources. In the case of households IH2 and H7 this was, in part, a reflection of the availability of both lowland and upland areas. Household H2 was simply a very diversified system. In contrast, three of the four households with low diversity (IH8, H6, H8) had some limiting condition on their system. Households IH8 and H8 were limited by labor availability and had adopted relatively simplified systems. Household H6 was limited by the lack of available land.

Adaptability

The seventh and final agroecosystem criteria assessed at the household level was adaptability. As noted in the methods chapter, adaptability is best assessed with time-series or historical data. Since I had neither of these, I used my personal assessment informed by residents comments. I gave particularly high weight to residents reports of ongoing experimentation with new management systems and to reports of these activities in the past. Since I was not able to collect this type of information from all residents, I also used community-based information about system changes over time and compared that to individual practices.

I applied these criteria and rated five households (IH1, IH2, IH4, IH7, and H3) as high. All of these households mentioned currently experimenting with different management practices and the desire to continue to adapt their management system to changing conditions. I rated eight households (IH3, IH5, IH6, H1, H2, H4, H7 and H8) as moderate and seven households (IH8, H5, H6, UM1, UM2, UM3 and UM4) as low. The households that I rated low all demonstrated little evidence of having made any changes in their management systems in the past and did not indicate that they intended to make changes in the future. The households rated moderate were intermediate between these two extremes. Most of these households had made obvious changes in their management systems over time but did not explicitly indicate that they were actively involved in adapting their system to changing conditions.

Overall assessment

In this section of the chapter, I present and analyze the overall sustainability assessment at the household level. In order to combine the seven individual agroecosystem properties into an integrated assessment of sustainability, I followed the same procedures that I used at the community level. Using these procedures I created three different overall sustainability assessments based on an additive index, the law of the minimum and the dominant value respectively.

Additive index

The first and most commonly used method to combine a set of assessments or properties is the creation of an additive index. Therefore, this was the first method that I applied to the matrix of agroecosystem properties (Table 5.23). Since this was a seven property index, values from 7-11 were rated low; from 12-16 were rated moderate; and from 17-21 were rated high. The results of these calculations are shown in Table 5.24.

As in the previously discussed community level assessment, a large majority of the example households (15 of 20) were rated moderate. As was the case in the community-level ratings, households in Upper Magsaysay had the lowest level of sustainability (two low and two moderate). One additional household (H6) was rated low. The household rated low were the most marginal households in the study. Household H6 had no agricultural land of their own, and, although the households UM1 and UM4 had access to large land holdings, the soils were poor and they had access to few additional resources. Only two households (IH2 and H7) were rated high. Both households had highly diversified land resources including both upland holdings and irrigated *bukid*.

Law of the minimum

The second method that I used to combine the seven properties was the law of the minimum. This was an extremely strict criteria and, as a consequence, 14 of the 20 example households rated low and the remaining six rated moderate (Table 5.24).

Table 5.23. Agroecosystem properties matrix for example households

Household	Productivity	Stability	Maint	Resilience	Auto	Diversity	Adapt
IH1	Mod	Mod	Mod	High	Mod	Mod	High
IH2	Mod	Mod	High	High	High	High	High
IH3	Low	Mod	Mod	High	Mod	Mod	Mod
IH4	High	Mod	Low	Mod	Mod	Mod	High
IH5	Low	Mod	Low	High	Low	Mod	Mod
IH6	Mod	Mod	High	High	Mod	Mod	Mod
IH7	Low	Mod	High	High	Low	Mod	High
IH8	Low	Mod	Mod	High	High	Low	Low
H1	Mod	Mod	Mod	High	Mod	Mod	Mod
H2	Mod	Mod	Mod	High	Mod	High	Mod
H3	Mod	Mod	Mod	High	Low	Mod	High
H4	Low	Mod	High	High	Mod	Mod	Mod
H5	Low	Mod	Low	High	Mod	Mod	Low
H6	Mod	Mod	Low	Mod	Mod	Low	Low
H7	High	Mod	Mod	High	Mod	High	Mod
H8	Mod	High	High	High	Low	Low	Mod
UM1	Low	Mod	Low	High	Low	Low	Low
UM2	Low	Mod	Low	High	Mod	Mod	Low
UM3	Mod	Mod	Low	High	Mod	Mod	Low
UM4	Low	Mod	Low	High	Low	Mod	Low

Table 5.24. Overall sustainability rating for example households

Household	Additive index	Law of the minimum	Dominant value
IH1	Moderate (16)	Moderate	Moderate (5)
IH2	High (19)	Moderate	High (5)
IH3	Moderate (14)	Low	Moderate (5)
IH4	Moderate (15)	Low	Moderate (4)
IH5	Moderate (12)	Low	Low/Moderate (3)
IH6	Moderate (16)	Moderate	Moderate (5)
IH7	Moderate (15)	Low	High (3)
IH8	Moderate (13)	Low	Low (3)
H1	Moderate (15)	Moderate	Moderate (6)
H2	Moderate (16)	Moderate	Moderate (5)
H3	Moderate (15)	Low	Moderate (4)
H4	Moderate (15)	Low	Moderate (4)
H5	Moderate (12)	Low	Low/Moderate (3)
H6	Low (11)	Low	Moderate (4)
H7	High (17)	Moderate	Moderate (4)
H8	Moderate (15)	Low	High (3)
UM1	Low (10)	Low	Low (5)
UM2	Moderate (12)	Low	Low/Moderate (3)
UM3	Moderate (13)	Low	Moderate (4)
UM4	Low (11)	Low	Low (4)

All of the households in Upper Magsaysay received low ratings. This was due to the low levels of maintenance and adaptability that were found across the entire community including in all four example households. In the other two communities, 10 households were rated low and the remainder were rated medium.

In Imbarasan / Himamara, the low ratings were driven by low productivity levels in five of six cases and by low maintenance in the remaining case (IH4). In two households (IH5 and IH7) low productivity ratings were combined with low autonomy (IH5, IH7); in a third (IH8) with low diversity and adaptability. In contrast, low values of productivity (H4, H5), maintenance (H5, H6), and autonomy (H3, H8) were equally important determinants in Halang.

Dominant value

The third method that I used to combine the property ratings assigned the household a rating equivalent to the most common property rating. Application of this rule led to a range of values across households and communities (Table 5.26). As with the previous two methods, moderate ratings were the largest group (11 of 20). Three of the remaining nine households were rated high, three were rated low, and the remaining three were rated equally low and moderate. Overall ratings followed the same community patterns as under the previous two methodologies. Upper Magsaysay ratings were lower (two low, one low-moderate, one moderate) while the other two communities were dominated by moderate ratings.

Summary

Overall, the household-level sustainability ratings were generally consistent across integrating methods. Ratings using the additive index method were strongly correlated with ratings from the other two methods. (Table 5.25). However, the correlation between the dominant value and law of the minimum methods was somewhat lower. These results indicated that the additive index may have captured similar information to the other two methods. However, because of biases toward the lowest rating (law of the minimum) and the modal value (dominant value method), the other two methods emphasized somewhat different aspects of the overall systems.

Table 5.25. Correlation matrix for overall sustainability rating methods at the household level (Spearman's ρ, N = 20)

	Additive index	Law of the minimum	Dominant value
Additive index	1.0	0.49 (0.03)*	0.49 (0.03)
Law of the minimum		1.0	0.34 (0.15)
Dominant value			1.0

*Numbers in parenthesis are the probability that Spearman's $\rho = 0$.

In addition to being consistent across methods, the household ratings were generally consistent with the community ratings discussed earlier in this chapter. Ratings from Upper Magsaysay households were generally consistent with the low community level rating. Eight of the twelve individual household ratings (four households, three methods) were low and one additional rating was low/moderate.

As was the case with the community ratings, the household-level ratings in Imbarasan / Himamara and in Halang were dominated by moderate ratings under the additive index and dominant value methods and by low ratings under the law of the minimum method. However, the household-level analysis using the additive index and dominant value methods brought out some of the within-community variation by identifying example household systems with higher and lower than average sustainability levels.

Relationships between individual properties and overall sustainability

When the individual property ratings in Tables 5.23 were compared with the overall ratings in Table 5.24, higher levels of sustainability were generally related to higher levels of productivity, maintenance, diversity and adaptability. In general these households had a larger number of available resources and a corresponding increased diversity of activities. One or more of these activities had moderate or high productivity, and one or more activity had high levels of stability and maintenance. Major activities of this type were *palay bukid* cultivation and management of one or more perennial species.

On the other side of the coin, households with low sustainability ratings were generally those households with limited access to resources, or with access to poor quality resources, particularly land. Household H6 had access to only a small amount of land overall, and households UM1 and UM4 had access to poor quality land. These households were also generally using management systems that had a lower level of maintenance, such as *kaingin* cultivation of steep slopes, particularly the households in Upper Magsaysay.

Interactions between properties

In the previous two sections, I provided ratings of each of the individual agroecosystem properties and of overall system sustainability at both the community and household level. I also provided brief discussions of how the ratings of individual properties were related to overall sustainability ratings. In this section, I examine some of the interactions between properties that have been proposed by other researchers. These include negative interactions between properties (trade-offs) and positive interactions between properties (complementarity). In order to better frame the discussion of trade-offs and complementarities, I computed a matrix of Spearman's correlation coefficients from the ratings presented in Table 5.23. This matrix is presented in Table 5.26.

Trade-offs

In the literature review chapter, chapter 2, I briefly discussed the potential for trade-offs between agroecosystem properties. Several of these trade-offs have been suggested based primarily on theoretical considerations. I used the information from the agroecosystem properties matrices (Tables 5.10 and 5.23), the overall sustainability ratings (Tables 5.11 and 5.24), and the matrix of correlation coefficients derived from Table 5.23 (Table 5.26) to determine if there was evidence for this trade-off process in the study communities and example households. I assessed six

Table 5.26. Correlation matrix of the household-level agroecosystem property values (Spearman's ρ values, N = 20)

	Prod	Stab	Maint	Resil	Auto	Divers	Adapt
Prod	1.0	.22	.11	-.39*	.21	.29	.40*
Stab		1.0	.29	.11	-.45**	-.25	.25
Maint			1.0	.35	.05	.11	.46**
Resil				1.0	-.13	.25	-.03
Auto					1.0	.26	-.05
Divers						1.0	.40*
Adapt							1.0

*Significant at $P(\rho = 0) < 0.10$
**Significant at $P(\rho = 0) < 0.05$

different potential trade-offs: productivity-stability, productivity-maintenance, productivity-autonomy, stability-resilience, autonomy-resilience and autonomy-adaptability.

Productivity-stability

The first trade-off assessed was between productivity and stability. The analysis results from this study did not support the existence of a trade-off between these two properties. In fact the household-level data showed a positive correlation (Spearman's $\rho = 0.22$) between the two properties. However, because of the small amount of variation in the household level stability ratings, this correlation coefficient was somewhat suspect. In contrast to the theoretical trade-off between productivity and stability, in these communities, factors that increased productivity also increased stability. The most important examples were: the adoption of irrigated rice cultivation which increased both the productivity and stability of rice harvests, and having livelihood activities with complementary labor demands such as rainy season annuals and dry season charcoal. This increased overall system productivity and stabilized returns through diversification.

Productivity-maintenance

The second theoretical trade-off between properties was between productivity and maintenance. This trade-off assumed that high productivity could only be obtained at the expense of the resource base (lower maintenance). The results of this study showed no evidence of this trade-off. In fact, the two properties showed a small, not statistically significant, positive correlation (Spearman's $\rho = 0.11$). However, the root causes behind this correlation differed between the communities.

In Halang, the relationship was likely caused by a positive feedback relationship between the use of acid-forming ammonium sulfate fertilizer and the weathering of the calcareous and phosphorus containing parent material to release previously unavailable nutrients. The use of fertilizers helped Halang residents to have moderate productivity levels and the accelerated weathering appeared to be creating new soil at a similar rate to the soil losses from cropping and erosion. In contrast, in Imbarasan / Himamara and in Upper Magsaysay, environmental variables (such as terrain and soil quality) appeared to be influencing both properties in the same direction.

Productivity-autonomy

The third proposed trade-off was the trade-off between productivity and autonomy. The theoretical existence of this trade-off was supported by the hypothesis that in order to get high levels of productivity, land managers must use outside inputs such as fertilizers. Overall, the data from the three study communities did not support the existence of this trade-off. At the household level, the properties showed a weak, positive correlation (Spearman's $\rho = 0.21$). However, even though this trade-off was not supported by the aggregate analysis data, interviews with residents and my observations supported the existence of a trade-off between the two properties for specific household system components. For example, lowland rice yields in Imbarasan / Himamara were above national averages and were a significant component of many livelihood systems. However, this increased rice productivity had come as a result of increased use of fertilizer inputs. This had, in turn, resulted in increased use of credit. Both of these reduced household autonomy. A similar situation existed in Halang with taro cultivation which was highly productive and lucrative if fertilizer inputs were used and an outside market was available.

Stability-resilience

The fourth proposed trade-off is between stability and resilience. As in the case of the first three trade-offs, the study data did not support the existence of a trade-off between the properties and instead showed a weak, not statistically significant, positive correlation (Spearman's $\rho = 0.11$). However, because nearly all households were rated high for resilience and nearly all households were rated moderate for stability, this correlation coefficient was highly suspect. Interview and observational data also did not support the existence of this trade-off. In most cases in the three communities, factors that increased the stability of livelihood systems such as diversification of enterprises and the cultivation of irrigated rice also increased system resilience.

One potential area for a negative relationship between the properties was in the increased focus on perennial species. Some fruit tree species (e.g., mango) are susceptible to severe damage from high winds. In Halang and Upper Magsaysay, storms severe enough to damage mango trees were common and could be considered as a regular factor affecting year-to-year system stability. It is possible, however, that a manager in Imbarasan / Himamara who shifted exclusively to mango cultivation could gain in year-to-year stability at the risk of catastrophic loss from a rarer, severe typhoon. No current resident was in this situation.

Autonomy-resilience

The fifth proposed trade-off that I examined was between autonomy and resilience. This trade-off was hypothesized to occur because highly autonomous households might not have the resources to recover from severe shocks. In contrast, households with low autonomy might have more access to resources to help them recover. The study data did not support the existence of this trade-off either; although the properties showed weak, negative relationship (Spearman's $\rho = -0.13$). As in the case of the stability-resilience trade-off, the small variation in the resilience ratings across households made this correlation coefficient highly suspect. Interviews with residents and my personal observations did not produce evidence either for or against the existence of this trade-off.

Autonomy-adaptability

The sixth and final trade-off that I considered was between autonomy and adaptability. The existence of this trade-off supposed that a high level of autonomy might leave a household without access to outside information and new ideas. Without these outside inputs, a household would be less able to adapt to changing circumstances. The existence of this trade-off also was not supported by the analysis data. The properties showed a very weak, negative relationship (Spearman's $\rho = -0.05$). Data from interviews supported the existence of this trade-off to a limited extent for some specific households. In particular, household IH8 was an example of a highly autonomous household that had shown only a low level of adaptability and had used essentially the same management system for over 30 years. However, the other household in the same community with a high autonomy rating, IH2, rated high on adaptability. This household had been changing their system to grow more of their own food supply and to reduce dependence on off-farm labor. This had led to a high level of autonomy.

Complementarity

Not all interactions between the agroecosystem properties were believed to be negative interactions. Other researchers had also hypothesized the existence of positive interactions between the properties. Many of these interactions are founded in the theoretically pivotal role played by diversity in household livelihood systems. I examined four possible complementary interactions: diversity-productivity, diversity-stability, diversity-resilience and diversity-adaptability.

Diversity-productivity

The first potential complementary interaction that I examined was the positive relationship between diversity and productivity. In theory, increased diversity could lead to increased productivity by allowing the household to make better use of resources (e.g., land, labor) and by providing a greater variety of products for home use or for sale. This hypothesis was supported by the analysis data at the household level. The properties showed a positive correlation (Spearman's $\rho = 0.29$). This relationship was also supported by data from interviews and from my observations. In all three communities, households that had greater diversity, particularly a greater variety of productive enterprises, also had higher overall productivity. This was particularly true for income-based measures of productivity.

Diversity-stability

The second hypothesized complementary relationship was between diversity and stability. This relationship was founded on the idea that as well as increasing productivity, increased diversity would increase system stability. This hypothesis was not supported by household level analysis data. The two variables were negatively correlated (Spearman's $\rho = -0.25$); however, as mentioned previously, all correlations that involved stability were suspect because of the low variation in stability ratings across households. In spite of the lack of evidence from the aggregate ratings data, interviews and observations that I made in the communities tended to support this assertion in general especially when diversity was conceptualized as different types of activities (guilds) or income sources, not just as different individual species. Households with multiple guilds (e.g., annual grains, legumes, livestock, fruit trees, charcoal) tended to have more stability than households with a smaller variety of activities. I observed the same effect for the variety of available income sources.

Diversity-resilience

The third potential complementary interaction was between diversity and resilience. The dynamic involved in this proposed interaction was much the same as that for stability. Greater diversity of options was likely to make a household less vulnerable to large shocks that effect one or a small number of the components. The study results supported the existence of this relationship. The variables were positively correlated (Spearman's $\rho = 0.25$). However, because of the lack of variation in resilience ratings across households, this correlation coefficient was suspect. As discussed above for stability, the relationship appeared to hold, at least in general for a significant number of households in all three communities, particularly when diversity was conceptualized not as diversity of species but as diversity of species types or activities.

Diversity-adaptability

The final potential complementary interaction that I discuss was between diversity and adaptability. This interaction was founded on the idea that the ability to adapt requires options from which to choose. Maintaining diversity within a system was one way to preserve the widest variety of options and allow for easier adaptation to future circumstances. This relationship was strongly supported by the study results. The properties showed a statistically significant, positive correlation (Spearman's $\rho = 0.43$, $p(\rho = 0) < 0.10$). Although no residents explicitly mentioned this relationship in interviews, those households that mentioned activities, such as ongoing experimentation, that indicated high levels of adaptability also generally had the most diverse systems.

Evaluation of the methodology

In the previous sections, I presented the analysis results from my use of the agroecosystem properties to assess sustainability at both the community and household levels. In this section, I present a brief evaluation of the study methodology both within the context of the objective of this section, to assess system sustainability, and in the context of the overall study objectives of better understanding the processes and constraints behind the development of sustainable systems in Philippine upland environments.

Study objective number two

The first criteria used to evaluate the methodology was how well it provided an answer to the study question from Chapter 2: How do we identify persistence?, and how well it met study objective number two: To evaluate the sustainability of household livelihood systems using the agroecosystem analysis properties.

Based on these criteria, the analysis methodology did a good job. I was able to develop logical and defensible ratings for all nine agroecosystem properties for the three study communities and for the twenty example households. The individual properties provide snapshots of a wide range of system aspects. And, I was able to integrate the properties into three separate single indices of sustainability.

The sustainability ratings at both the community and household levels paralleled my professional opinions about the relative likelihood of these management systems being sustained for the next 10-20 years if there are no major changes overall socio-political context of the three communities. However, there are some outside factors that could strongly affect sustainability, either positively or negatively. In Halang, increasing development pressure on the area could inflate land values and encourage residents to sell their land and leave the area. Although households could continue to live on the earnings from land sales, the existing natural resource management systems would disappear. The situations in Upper Magsaysay and Imbarasan / Himamara could also be influenced by changes in socio-economic context, particularly improvement of infrastructure. However, in these cases, the influence on sustainability is likely to be positive as it may facilitate the development of market-oriented systems based on perennial species.

Although the methodology provided consistent results that paralleled my professional opinion, there were some problems and drawbacks to the methodology. First of all, the analysis results were very broad and significant amounts of detail were lost during the analysis process. This seemed to be particularly true at the community level for all properties and the overall sustainability assessment and at the household level for the overall sustainability assessment. This observation was not surprising given the methods I used. At the community level, all properties were assessed as indices based on community averages. It is not surprising that this type of calculation showed a tendency to shift toward moderate levels. This was perhaps best illustrated by the observation that, in spite of significant differences, all three communities received moderate ratings for overall sustainability.

A second issue that came out of using the methodology on this particular data set was that nearly all households and all three communities rated low or moderate on most properties. This made it more difficult to discern differences between the individual households and communities. There appeared to be at least three reasons for this situation. The first reason is the issue of convergence mentioned in the previous paragraph. Most of the properties were assessed using indices based on several indicators. These indices showed the same tendency toward moderate values as the overall sustainability ratings.

Third, the properties were assessed based primarily on external standards. National and international averages for productivity, diversity, and equitability since data was available. Maintenance ratings were based a standard of minimum degradation of land resources. Autonomy, solidarity and adaptability were all based on researcher-derived standards that were derived from general information, although informed by community data. Stability and resilience were assessed using indicators primarily derived from community norms; however, these two properties showed the least variation across households of the seven properties considered at the household level and so were not particularly informative.

This small amount of variation in the household ratings for stability and resilience may have been an artifact of the community and household selection processes. Since I set out to study communities and households that had persisted in upland areas for many years, it was not surprising that residents had developed management systems with generally moderate levels of stability. With regard to resilience, residents may have either developed systems with generally high resilience, not experienced major shocks in their time in the area (only 20-40 years) or some combination of both of these factors.

A fourth important drawback to the use of this methodology for sustainability assessment was that determining reasonable ratings for all nine agroecosystem properties requires a significant amount of varied data. Although this research involved nearly one year in the field, I still lacked some of the data that would have been useful when trying to develop ratings for specific properties. Any sort of historical data for better assessment of stability, maintenance, resilience and adaptability would have been particularly useful and might have allowed me to avoid the problem of lack of variation in stability and resilience discussed in the previous paragraph. However, in practice longitudinal data has been very difficult to find for marginal areas such as uplands.

The fifth and final important potential problem with the study methodology was that the overall sustainability index, developed from the integration of the nine agroecosystem properties was difficult to interpret and more importantly was difficult to use either as a guideline for future action or as a tool to evaluate system changes. Since the index contained all nine properties, it was difficult to estimate how changes in one property would impact the overall index. In addition, the small changes in one or two properties that were likely to result from a development intervention (e.g., productivity increases due to the availability of lime for acid soils), were unlikely to impact the overall index even though they could have very significant positive effects on the livelihoods of specific households or even of the community as a whole.

Understanding the reasons behind livelihood sustainability

Even though the sustainability assessment methodology based on the agroecosystem properties did a reasonable job of assessing livelihood sustinability, I had also hoped that it would provide some clues that would lead toward a better understanding of the reasons behind differences in livelihood sustainability levels between households and communities. Unfortunately, this was not the case. The methodology offered very little information about why the levels of sustainability assessed were occurring. The examination of the interactions between various pairs of properties discussed earlier in this chapter provided some additional clues, but overall, the methodology could be used to identify the existing level of sustainability, but there was a need to go beyond this methodology to develop explanations for why the observed levels of sustainability existed.

Additional information

The primary weakness of the study methodology was that an assessment of the agroecosystem properties, although very informative, did not, in itself, provide any insight into the reasons why properties had particular values and by extension why households and communities had particular sustainability levels. In this section, I integrated some additional information, primarily on the environment where these livelihood system existed, in order to identify some of the reasons behind the generally low levels of various system properties and overall sustainability. I first discuss three components of the physical environment, terrain, climate and soils. This will be followed by a discussion of four socio-politico-economic factors: access, markets, information and political power. The section will conclude with a discussion of some of the inter-relationships between the seven individual factors.

Physical environment

One set of primary influences on a number of the individual agroecosystem properties and on overall sustainability consisted of the constraints and limitations imposed on management systems by the physical environment: the topography, the climate and the soils. The three factors individually and their interactions strongly influenced system assessments through their effects on productivity, stability, maintenance, resilience and diversity.

Topography

One of the most important factors that influenced management systems and affected the property ratings was the topography of the study communities. The primary impact of topography at the household level was that it determined the types of land available to most households. This in turn affected productivity, stability (through the ability or inability to irrigate), and maintenance (though soil erosion).

The favorable hill and valley topography of Imbarasan / Himamara has helped facilitate the development of more stable systems and has allowed a significant number of residents to employ *palay bukid* cultivation both rainfed and with irrigation. They have been able to take advantage of the increased productivity and stability of *palay bukid* over *palay kaingin*. In addition, at the household level, many residents were able to take advantage of natural erosion process to help maintain the fertility of their valley fields. In contrast, the vast majority of Halang and Upper Magsaysay residents were constrained to exclusively upland holdings. Although

Halang provided an example of how other factors could interact to increase the productivity of hillside lands, Upper Magsaysay provides a more typical example of an upland system constrained to the low-productivity, low stability and low maintenance activity of annual crop cultivation on steep slopes.

Climate

Another important physical factor that influenced household and community sustainability is climate. Climate, particularly as expressed in the amount and distribution of rainfall, played a powerful role in these types of systems by reducing the number and type of management options available to community residents. Climate also directly influenced overall productivity both through small fluctuations that affected stability and large events such as typhoons that severely shocked the management system. The amount and distribution of rainfall was very different in the three communities but had similar impacts on livelihood systems and by extension on agroecosystem properties.

In Upper Magsaysay, rain was plentiful and evenly distributed throughout the year. This increased the potential options available to residents and, all other things being equal, could have led to more system diversity and associated increases in productivity and stability as well as increased adaptability to changing circumstances. However, the community was regularly subject to severe storm events. As a consequence, systems with high resilience to hurricanes were preferred by residents in spite of lower values of other properties. In contrast, Imbarasan / Himamara and

Halang both had a rainfall distribution characterized by distinct rainy and dry season. This constrained certain options, such as many varieties of fruit trees, but opened others such as charcoal production.

Soils

The third segment of the physical environment that influenced the agroecosystem properties and the overall system sustainability was the soils. Soil development has been traditionally conceptualized as an interaction between five factors: parent material, climate, topography, time and organisms (Jenny, 1980). The soils in all three areas show various levels of influence from each of these five factors. Of particular importance were climate, topography and parent material. As mentioned earlier, the moderate levels of maintenance for most households in Halang were a direct result of the highly weatherable, calcareous parent material that allowed them to maintain soil fertility while using an intensive management system. On the opposite end of the spectrum, the highly weathered, acidic soils of Upper Magsaysay were one of the major reasons behind the extremely low levels of productivity and stability in that community. They also limited the potential for system diversification to those species that are adapted to acidic soil conditions. Soils in Imbarasan / Himamara were intermediate between these two groups and appeared to have relatively less direct effect on management systems; however, the relatively infertile upland soils were at the root of the low productivity ratings for upland crops in the community.

Socio-politico-economic factors

Although the physical environment had an important influence on management systems, the agroecosystem properties and overall system sustainability, it did not exist in isolation. The socio-politico-economic environment also had considerable influence on the agroecosystem properties and on overall livelihood system sustainability. For the purposes of clarity, I identified four individual socio-politico-economic factors: accessibility, markets, information, and political power. I discuss them individually in this section and discuss interrelationships in the subsequent section.

Accessibility

The first extremely important influence on systems was accessibility, specifically road access. Accessibility affected agroecosystem properties and overall system sustainability principally through its impact on the ability of households to transport and sell their products and to obtain inputs for production activities. Roads were very poor or non-existent in much of Upper Magsaysay and Imbarasan / Himamara. In Upper Magsaysay, this helped to make agricultural inputs prohibitively expensive. Without inputs, agricultural productivity was likely to remain at a very low level. Transportation difficulties also made it harder for residents to diversify to other, potentially more productive, management options. The situation was similar in Imbarasan / Himamara; however, transportation difficulties were not as severe, particularly in the dry season. Residents still repeatedly mentioned how infrastructure improvements would allow them to diversify their systems and increase both productivity and stability. In contrast, Halang was relatively easily accessible. Community residents could easily obtain agricultural inputs and sell agricultural products. As a consequence, they had been able to diversify their systems and had been able to increase agricultural productivity though the use of fertilizers.

Markets

The impact of market availability was very similar to that of infrastructure. Market availability allowed households that were interested to focus at least part of their production on non-subsistence products. In upland areas, many of the most promising alternative management strategies (e.g., fruit trees, timber trees, palms, etc.) involved systems based on perennials that must be sold in order for system managers to purchase basic household needs. Of the three communities, Halang had the best access to markets since it was located near Manila. Residents had been able to combine favorable soils, adequate infrastructure and the access to the Manila market to develop the most sustainable management system of the three areas in spite of severe environmental constraints.

Both Imbarasan / Himamara and Upper Magsaysay lacked this access to major markets. As mentioned earlier in the analysis, both Infanta, Quezon and San Jose, Occidental Mindoro were relatively small towns. As a consequence, prices, especially for seasonal products tended to fluctuate significantly and were generally very low at harvest time. Most residents in both areas felt that, even though a switch to a management system based on perennials was likely to increase overall productivity as well as stability and maintenance, the lack of secure markets made investment too risky.

Information

A third important variable was information. Residents in all three communities generally had few sources of advice regarding other potential alternatives to their existing management systems or ways in which they could improve their management systems. One typical source of this type of information would be the government through extension personnel. However, all three areas have received only minimal amounts of information through this channel. Officially, residents of Upper Magsaysay were not supposed to be living there, since it is a national park. As a consequence, no extension personnel from the Department of Environment and Natural Resources (DENR), which has jurisdiction over the majority of upland areas, were assigned to Upper Magsaysay. A DENR technician was assigned to Imbarasan / Himamara; however, his activities there were only a small part of his overall job duties. So, he spent most of his time in the area taking care of necessary paperwork and very little working with farmers on their management systems. The situation was somewhat different in Halang since it was an agrarian reform area; however, the results were the same. The agrarian reform technician assigned to Halang, by his own admission, had no background in agriculture and so had very little advice to offer local residents regarding management alternatives.

Since they did not obtain much information through official government channels, residents in all three communities reported obtaining the vast majority of their management information from relatives or friends. There were some exceptions to this. In Imbarasan / Himamara, cashew and melina tree cultivation was first introduced in the late 1980's by the DENR staff and me while I was a Peace Corps volunteer working in the area. Cashews and melina were both becoming increasingly common. In Halang, some residents were involved with and receive information from a joint project focusing on management alternatives being conducted there by SEARCA and the Queensland Department of Primary Industries (Australia). Recent efforts to provide farmers in Upper Magsaysay with additional information were also underway under the auspices of ICDAI (a local NGO) and the FAO sponsored FARM program.

Political power

The fourth socio-politico-economic factor that influenced system sustainability was political power. All of these areas were politically marginal and did not have much influence with government officials at any level from local to national. Both Halang and Upper Magsaysay had residents who served on the *barangay* council for their respective *barangay*. However, these councils had little practical power, very few resources and were dominated by representatives from more densely populated portions of both *barangay*. Imbarasan / Himamara lacked even this representation. At the municipal level, all three areas were parts of relatively marginal barangays that had little clout in municipal decision-making.

Interrelationships

Even though an analysis of each of the seven factors discussed above provided useful information, their influence on individual agroecosystem properties and, more importantly, on overall livelihood system sustainability was more often the result of interrelationships between the variables. In this section, I discuss several interrelationships: productivity-accessibility,

Productivity-accessibility

The first interrelationship was the feedback loop between low productivity, and accessibility. This cycle started with the physical environment that in all three sites was not conducive to high levels of production (of virtually any agricultural crop) without the use of external inputs. Since residents in the area produced only low levels of often low value products for sale, there was little private incentive on the market side to facilitate access to the area. In addition, since residents had little to sell, they did not have the resources to improve access themselves. However, it was extremely difficult, if not impossible, to improve production without inputs that are external to the area and needed to be transported in (such as lime). But, without roads, getting inputs to upland farms was very expensive. So, residents could not obtain inputs. Their system productivity stayed low. And the cycle continued.

A variation on this cycle was that low accessibility made it difficult for residents to adopt management alternatives, such as fruit tree cultivation, that would be more sustainable environmentally (higher maintenance and productivity), but produced products that must be sold. Once a high-value product was available, it would be possible that private investment on the buyer end would work to facilitate improved access (as happened in the case of timber production in Upper Magsaysaya and Imbarasan / Himamara) but this required a product to sell. However, residents were very reluctant to make the initial investment in a new enterprise without assurance that accessibility would improve. And so, management alternatives were generally not adopted.

An interesting potential exception to these feedback loops was the increased cultivation of timber tree species in Imbarasan / Himamara. In this case, several larger landowners in nearby areas had started tree plantations. Some community residents had decided to plant timber trees with the belief that they could piggy-back their production on the infrastructure developed by these larger producers.

Productivity-stability-markets

The second interrelationship involved feedback between productivity, stability and markets. One commonly suggested set of alternative management strategies for upland areas were based on the cultivation of fruit trees or other perennial species for sale. During the study, many residents expressed a reluctance to invest their scarce resources (resources are scarce because present systems have low productivity) in perennial species in part because markets were not well developed. In both Imbarasan / Himamara and Upper Magsaysay, products were sold in small urban markets where prices were very sensitive to small changes in supply. However, to interest buyers in transshipping a product to a large market, for example mangoes from Mindoro to Manila, residents must be able to guarantee a significant and stable supply of the product. This would require significant, relatively coordinated investment by area residents. They were reluctant to do this because of the risk involved, particularly for the earliest producers.

Halang provided an interesting example of a similar but opposite relationship. In Halang, nearly all residents produced taro as a cash crop. There was a well developed marketing network involving buyers who came to the area to purchase taro and who provided up-front financing to producers for agricultural inputs. As a consequence, taro productivity had increased and the number of taro producers had increased, insuring buyers of a relatively stable supply.

Political power-accessibility-information

Since the productivity of these areas was low and residents had limited resources, they looked to the government to provide some of the things that would help them improve production such as accessibility and information. Unfortunately, the three study communities and Philippine upland communities in general were some of the least powerful communities and people in the country. Given this, it was perhaps not surprising that they generally lacked government investment in roads that would improve accessibility and in the extension services that might provide information on alternative management strategies.

Chapter 6
Household land management decision making

In the previous two chapters, I addressed the first two study objectives of describing the existing systems in the three study communities and assessing the sustainability of these systems using the agroecosystem analysis properties. In this chapter, I address the third study objective of modeling the decision making process for some common household land management decisions. Although this was not one of my original study goals during the field research, I had hoped to be able to use the data I collected to develop generic models of land management decision making; however, I was unable to develop suitable, generic models. There were two principal reasons for this: I did not collect a large amount of data specific to decision making and, more importantly, I was not able to perform the iterative process of model development and resident feedback that was necessary for the development of widely applicable models.

In spite of these difficulties and the data limitations, data was available to develop two types of decision models. The first group were a set of decision tree models of the processes residents used to choose their land management strategy, dry season *bukid* in Imbarasan / Himamara, and uplands in Imbarasan / Himamara, Halang, and Upper Magsaysay. The second group were a set of short case studies of the decision process used by six households, two in Halang and four in Imbarasan / Himamara, who have developed management systems where large perennials play a significant role. Systems based on large perennials are generally believed to be a potentially more sustainable land management alternative for upland areas. Information from these case studies was used to derive a set of common factors that appear to be important in the development of tree-based management systems.

This chapter is organized as follows. In the first section, I present the four decision tree models that represent residents land management decision making, primarily with regard to annual cropping options. This is followed by a discussion of the seven decision cases and their overall commonalities. The chapter concludes with a discussion of how these insights into decision-making complement the sustainability assessments of the previous chapter and address the original question posed in Chapter 2: How do we learn to persist?

Land management decision trees

In this section, I present decision trees for the major year-to-year land management decisions in the three study communities. Because of the very different management strategies used on lowlands and uplands in Imbarasan / Himamara, two decision models were necessary to adequately represent land management decisions. Since all of the study informants (including survey respondents) who had lowland holdings reported cultivating rice in rainy season on these holdings, this decision was not modeled. Because only a small number of residents in both Halang and Upper Magsaysay had access to lowlands, decision making models for these situations were not developed either.

All of the models described in this chapter were based on information provided by study informants. However, the exact decision tree sequence and a small amount of information necessary to fill in gaps in the model were based on the researcher's observations and perceptions of the situations in the three communities. Since it proved impossible to validate these models with local residents due to time and financial limitations, the models should be considered as schematic representations of household decision making processes, not as exact replications of the process households go through when making land management decision.

Imbarasan / Himamara dry season lowlands

Most of the household-level management decisions for lowland areas in dry season followed the same general pattern. As a consequence, a single decision tree model was used to simulate household decision making in this case (Figure 6.1). The primary goal for dry season cropping activities expressed by most households was earning extra cash income. Subsistence food production from dry season crops was generally a secondary goal. Residents reported six different cultivation options that were used in lowland fields during dry season: *palay bukid*, garlic, maize, vegetables (primarily melons but occasionally tobacco), mung bean and fallow. It is important to note that decisions were made on the basis of the specific conditions of small individual parcels, not the entire land holdings.

As indicated in the decision tree (Figure 6.1), water availability, availability of planting materials, and labor availability were the three major determinants of land

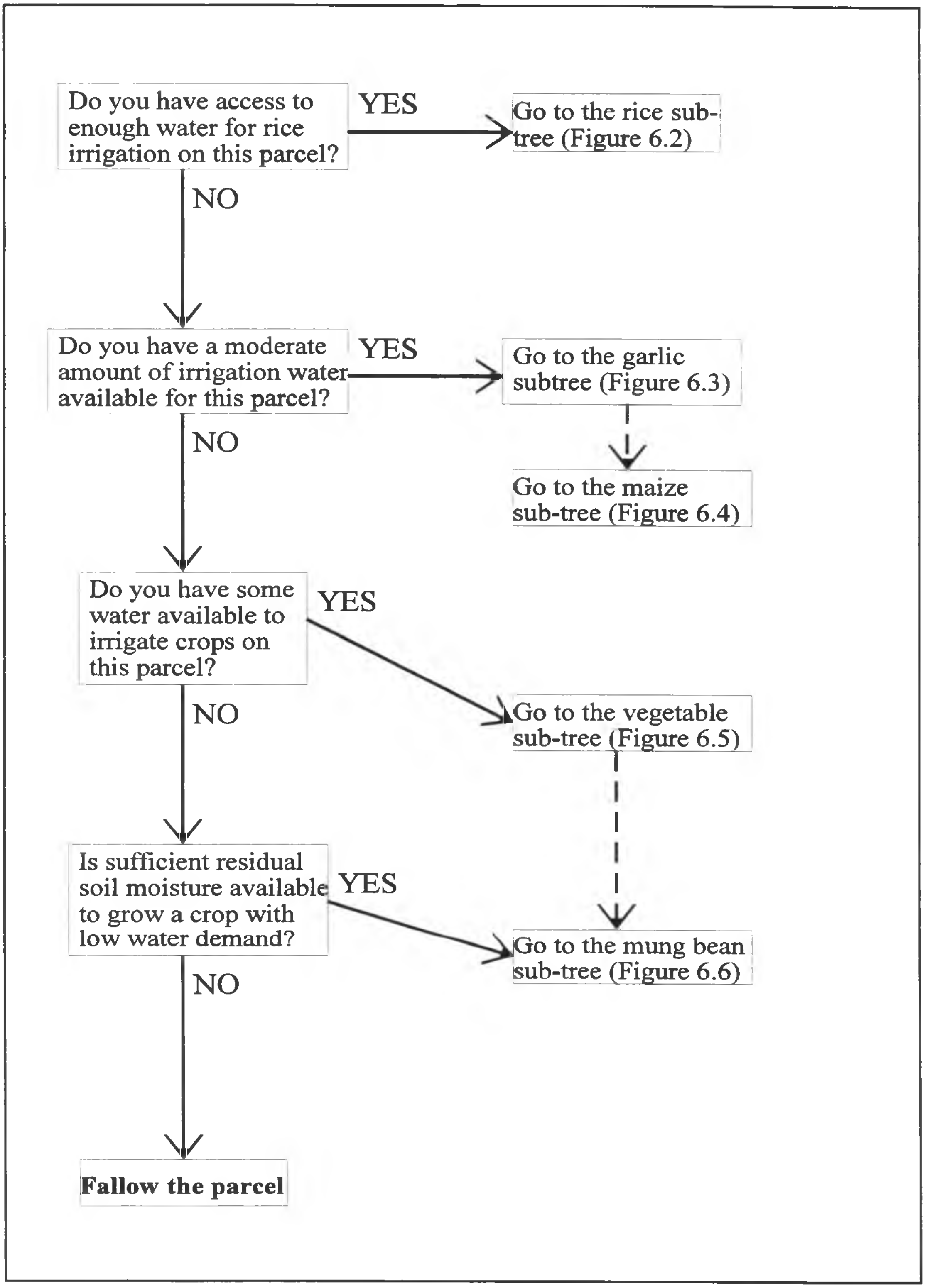


Figure 6.1. Decision tree for dry season management of Imbarasan / Himamara lowland parcels

management strategy choice. Residents generally started their decision-making process with the parcel that had the most available water. If ample water was available, most residents indicated that they preferred to plant a second crop of *palay bukid* (Figure 6.2). They indicated that dry season rice yields were generally significantly higher than rainy season rice yields. In addition, surplus rice (above family needs) could be sold or stored for future use or sale.

If a lesser amount of water was available, garlic had increasingly become the crop of choice (Figure 6.3). However, garlic planting materials were very expensive at planting time. So, the area planted to garlic was often limited both by water availability and by planting material availability. Furthermore, effective garlic management required more labor than a similar area of a grain or legume crop. This also may have been a constraint to specific households. Maize cultivation had similar water requirements to garlic and was generally less constrained by labor or planting material availability (Figure 6.4). So, maize was typically planted in the remainder of the area suitable for garlic but not planted to garlic for reasons other than water availability.

If only a small amount of water was available for irrigation, most households considered vegetable cultivation (Figure 6.5). The most common dry season vegetables in the area were melons (cantaloupe and watermelons) and tobacco. However, vegetable cultivation was also strongly constrained by labor availability (plants were generally hand watered) and by the availability of planting materials. In

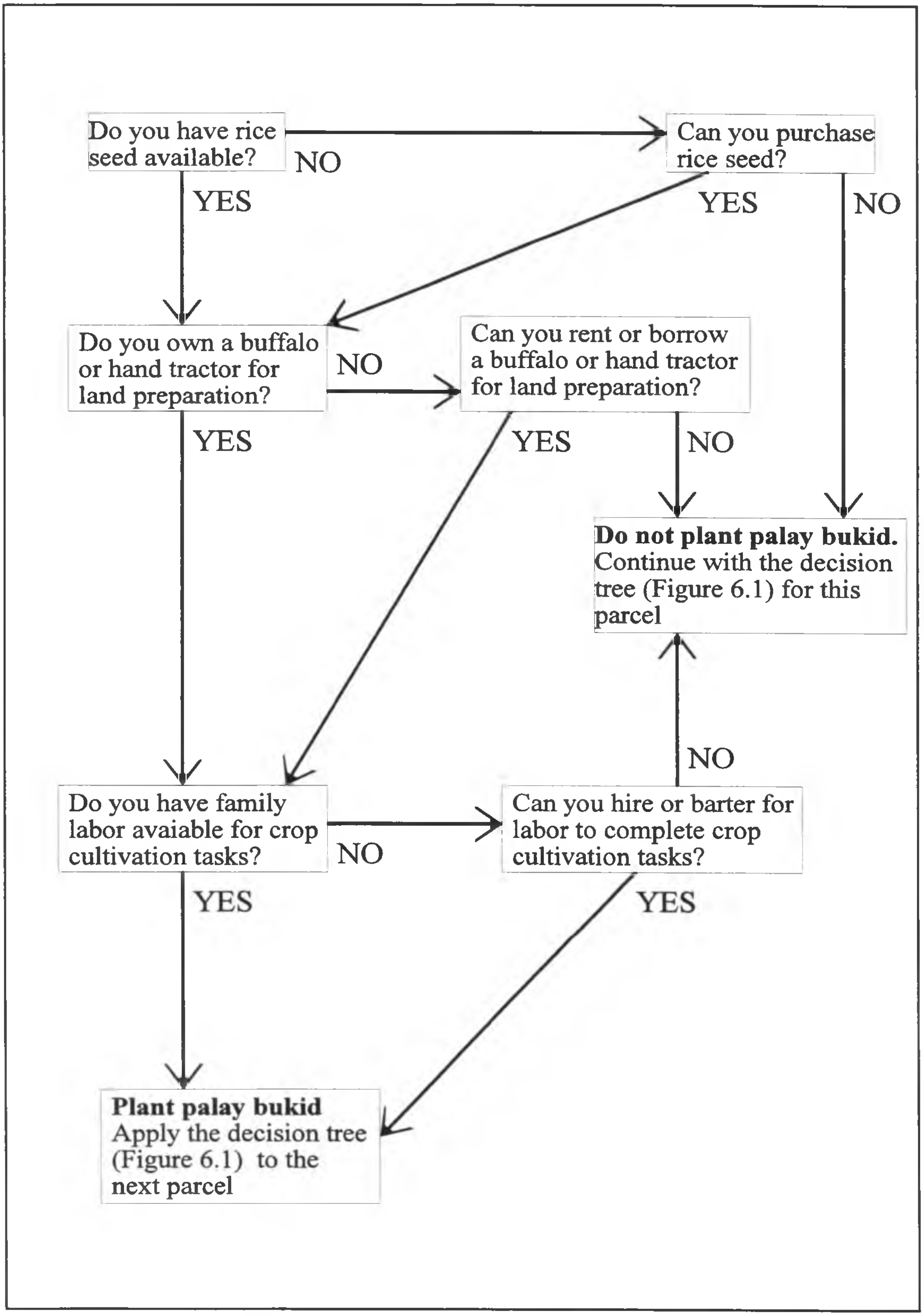


Figure 6.2. Rice cultivation sub-tree for Imbarasan / Himamara lowland parcels

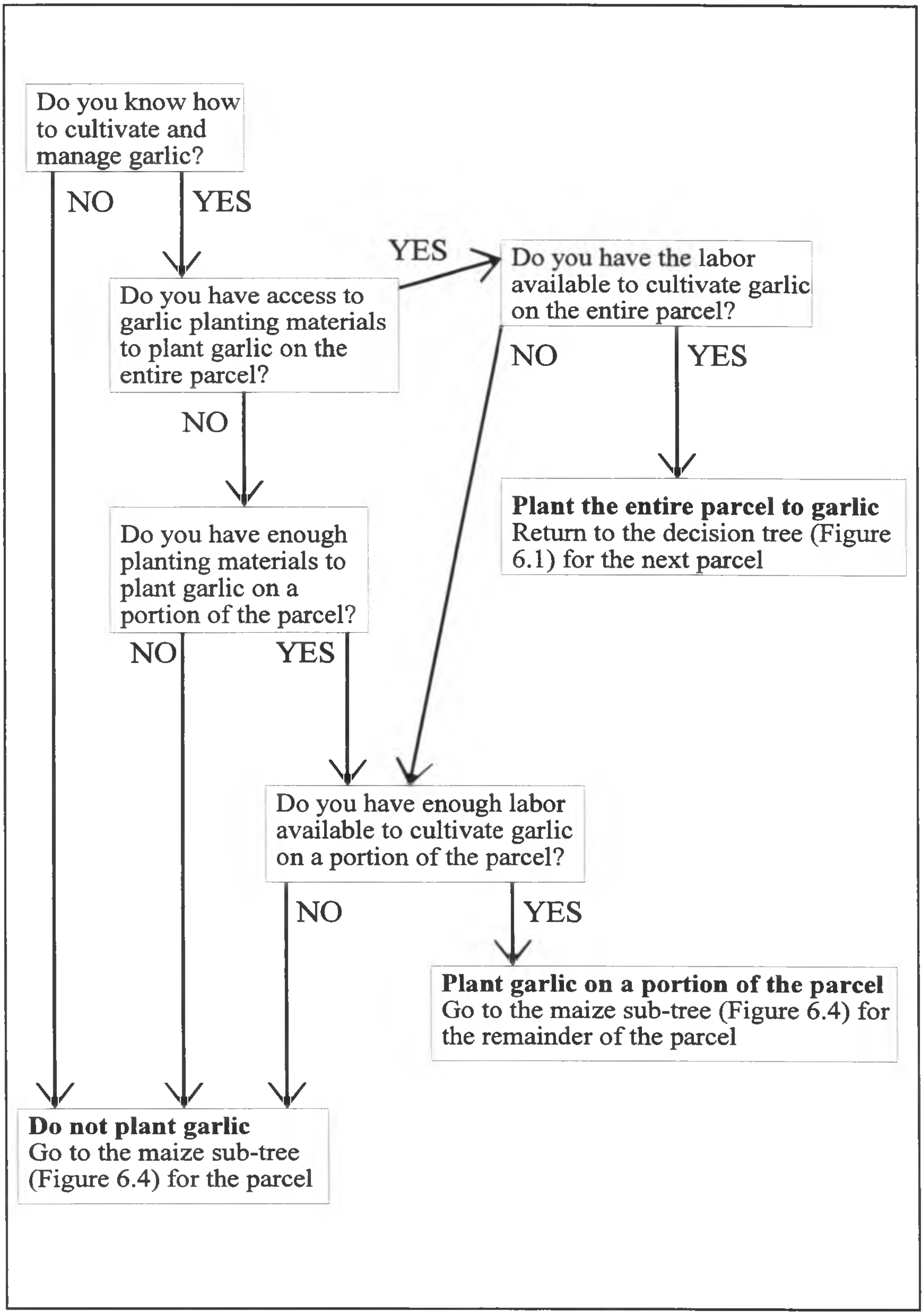


Figure 6.3. Garlic cultivation sub-tree for Imbarasan / Himamara lowland parcels

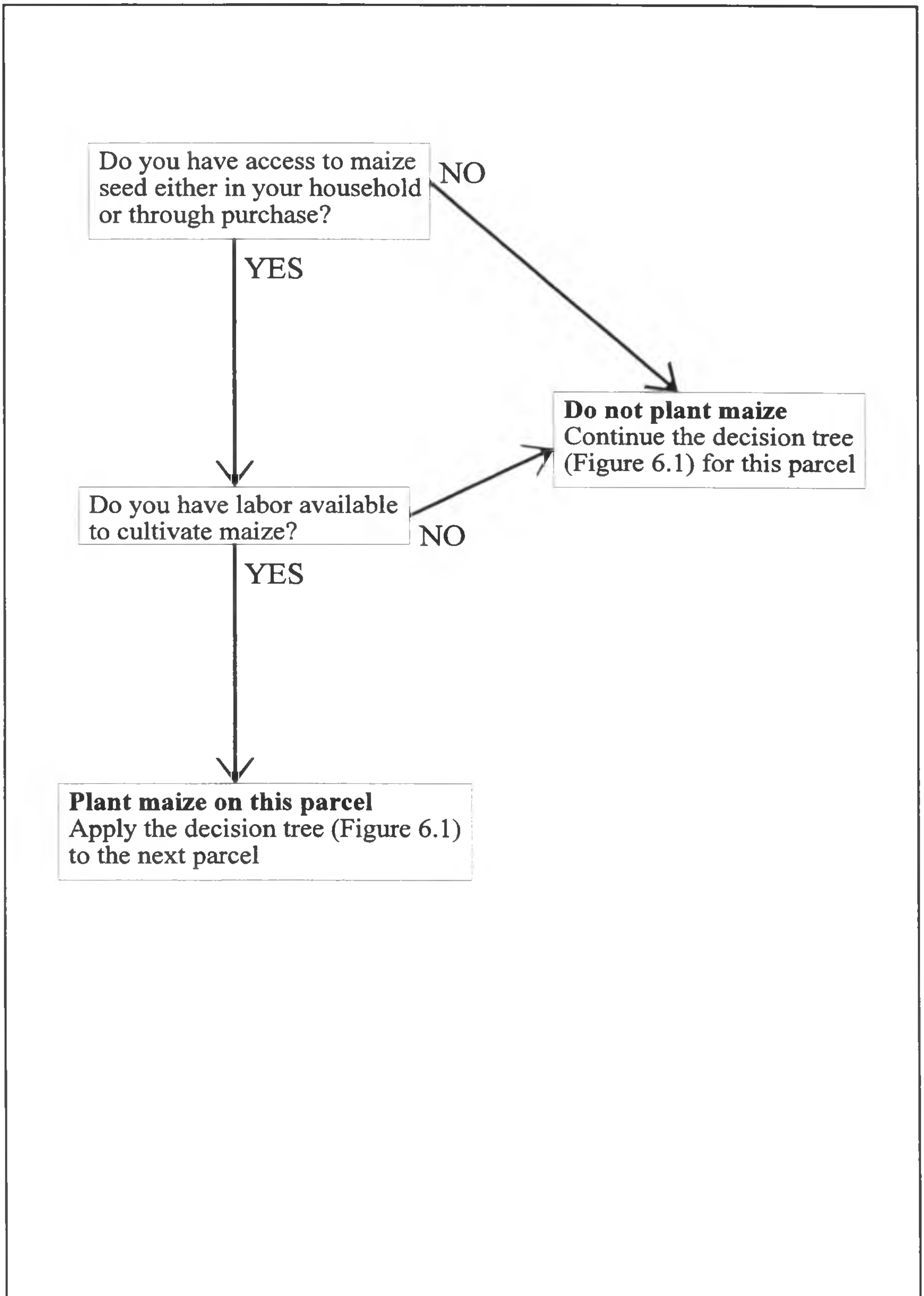


Figure 6.4. Maize cultivation sub-tree for Imbarasan / Himamara lowland parcels

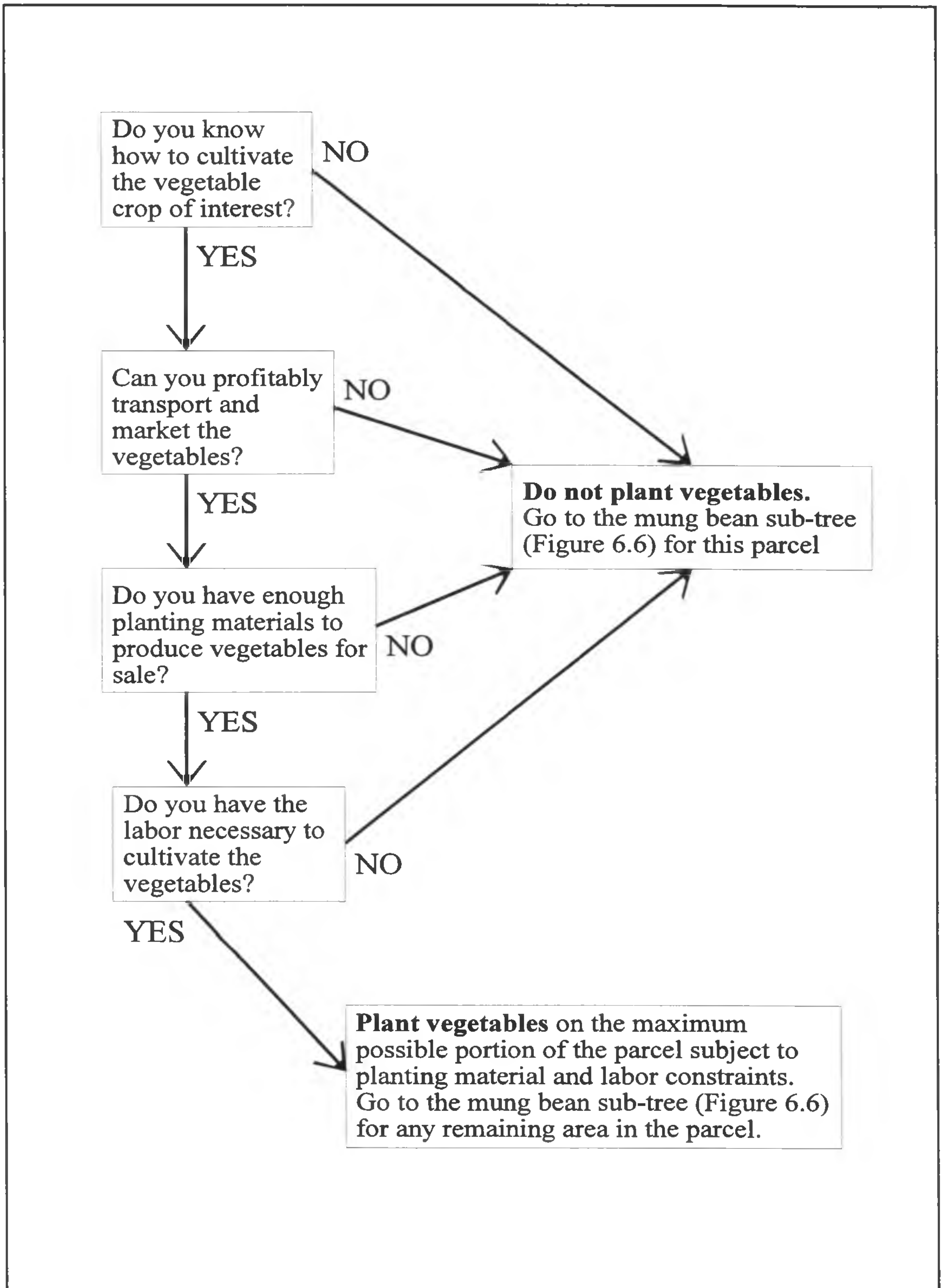


Figure 6.5. Vegetable cultivation sub-tree for Imbarasan / Himamara lowland parcels

the case of melons, access was another important constraint since they are quite heavy and thus difficult to transport.

If no water was available for irrigation during dry season, residents reported having two remaining management options: mung bean and fallow (Figure 6.6). The decision between the two strategies was based on resident estimates of residual soil moisture, labor availability and the availability of planting materials. If the household believed that there was sufficient soil moisture available from the previous rice crop, they planted mung bean. Mung bean was typically grown as a low input, low output crop. Residents reported not using inputs for two reasons: native varieties do not respond to chemical fertilizers and there was always a significant risk of very low yields due to water stress. Labor availability also limited the area planted to mung bean by some households. Although the crop was grown with low levels of management, harvesting took considerable labor. Planting material availability was also a constraint for some households. If the household was unable to cultivate mung bean due to one of the problems above, the land was left in dry season fallow. This fallow was generally not managed, although goats, cattle and buffalo are allowed to graze on the rice stubble.

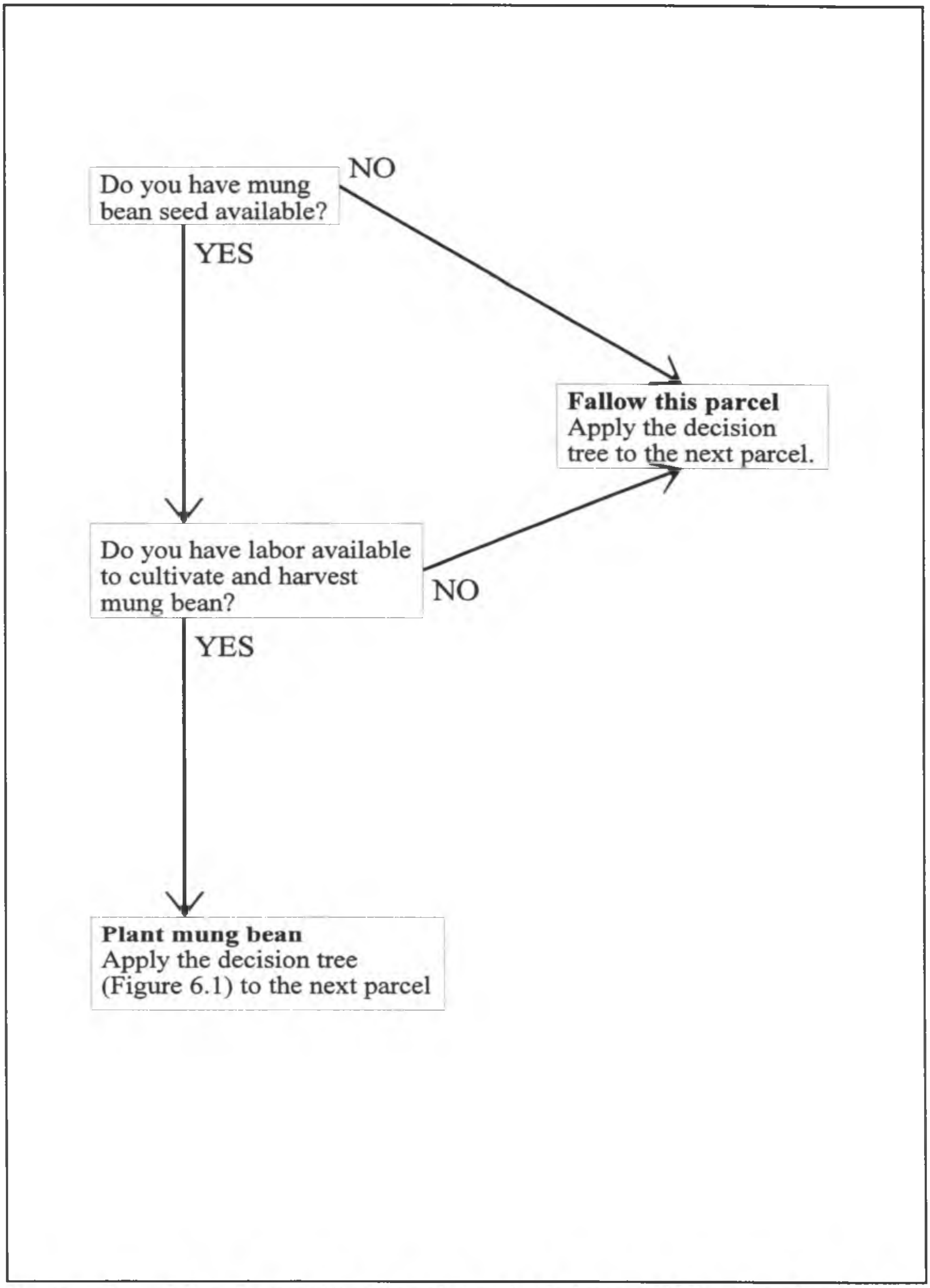


Figure 6.6. Mung bean cultivation sub-tree for Imbarasan / Himamara lowland parcels

Imbarasan / Himamara uplands

The second general model of land management that I present is a model of management decisions for upland parcels in Imbarasan / Himamara (Figure 6.7). According to residents there were three goals for the management of upland areas depending on specific household circumstances: subsistence food production, supplemental food production and production for cash income. Households managed their holdings to meet specific goals or combinations of these goals. One important determinant of household goals was the presence or absence of lowland holdings. Households that had lowland holdings generally managed their upland areas either for supplemental food production (particularly if lowland holdings were small) or for producing products for sale. In contrast, households without lowland holdings generally managed their uplands for subsistence production.

This distinction between the presence or absence of lowland holdings was the first factor considered in the land management decision tree (Figure 6.7). Virtually all households with lowland holdings in Imbarasan / Himamara concentrated their time and effort on these holdings and these lowland holdings often provided the household with sufficient amounts of annual crops. As a consequence, the second level of the decision tree for those with lowland holding asked whether or not the household required extra production or extra income from their upland holdings. If neither of these was important, the household was likely to leave any available upland areas in non-managed fallow. If supplemental annual crop production was important,

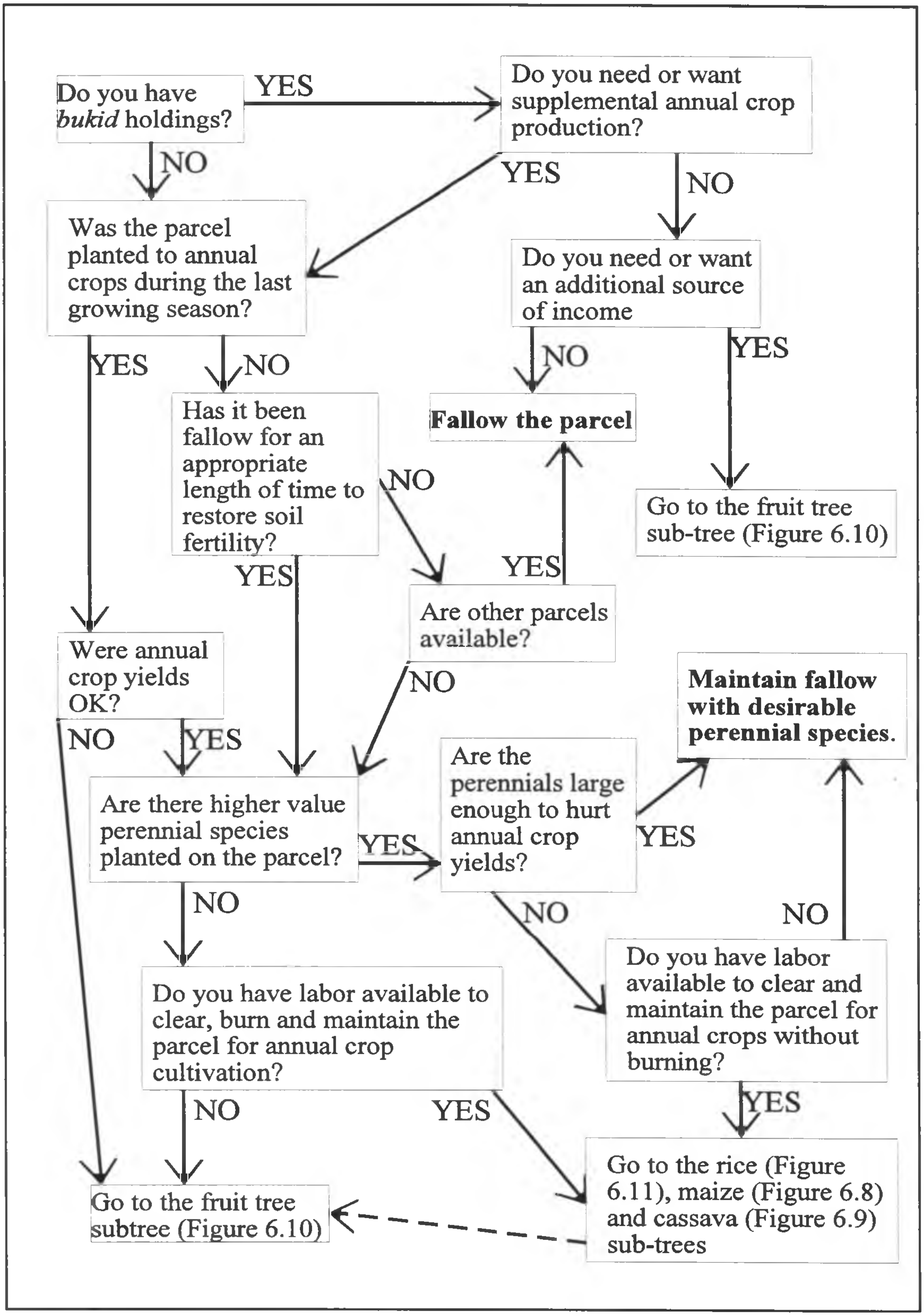


Figure 6.7. Main decision tree model for Imbarasan / Himamara upland parcels

households typically planted either maize (Figure 6.8) or cassava (Figure 6.9) depending on land, labor and planting material availability and on personal preference. If the primary interest in upland production was the generation of cash income, residents were more likely to practice a more intensive fallow management system including fruit trees (Figure 6.10) and multi-purpose trees used for charcoal production.

As mentioned previously, the second group of households, those without lowland parcels, were dependent on their upland parcels for their entire livelihood. As a consequence, their upland management goals were generally either subsistence production of annuals or sufficient production of saleable crops in order to be able to buy staple food supplies (rice). This group was also more likely to grow *palay kaingin* on their holdings. For these households, the typical decision sequence for a given parcel started with the present use of the parcel (Figure 6.7). If the parcel was cropped in the past year, residents considered yields from that year as the primary indicator of whether or not to continue cropping the area. If yields were considered poor, residents generally did not plant annual crops again but instead either planted fruit trees (Figure 6.10) or left the land to go fallow. Whether or not fruit trees were planted in the field during the first cropping season was the second land management consideration. If fruit trees had been planted, the area could be cleared for annual crops by burning because the burn would damage the trees. Clearing without burning required more labor in the clearing stage and more labor in during the season

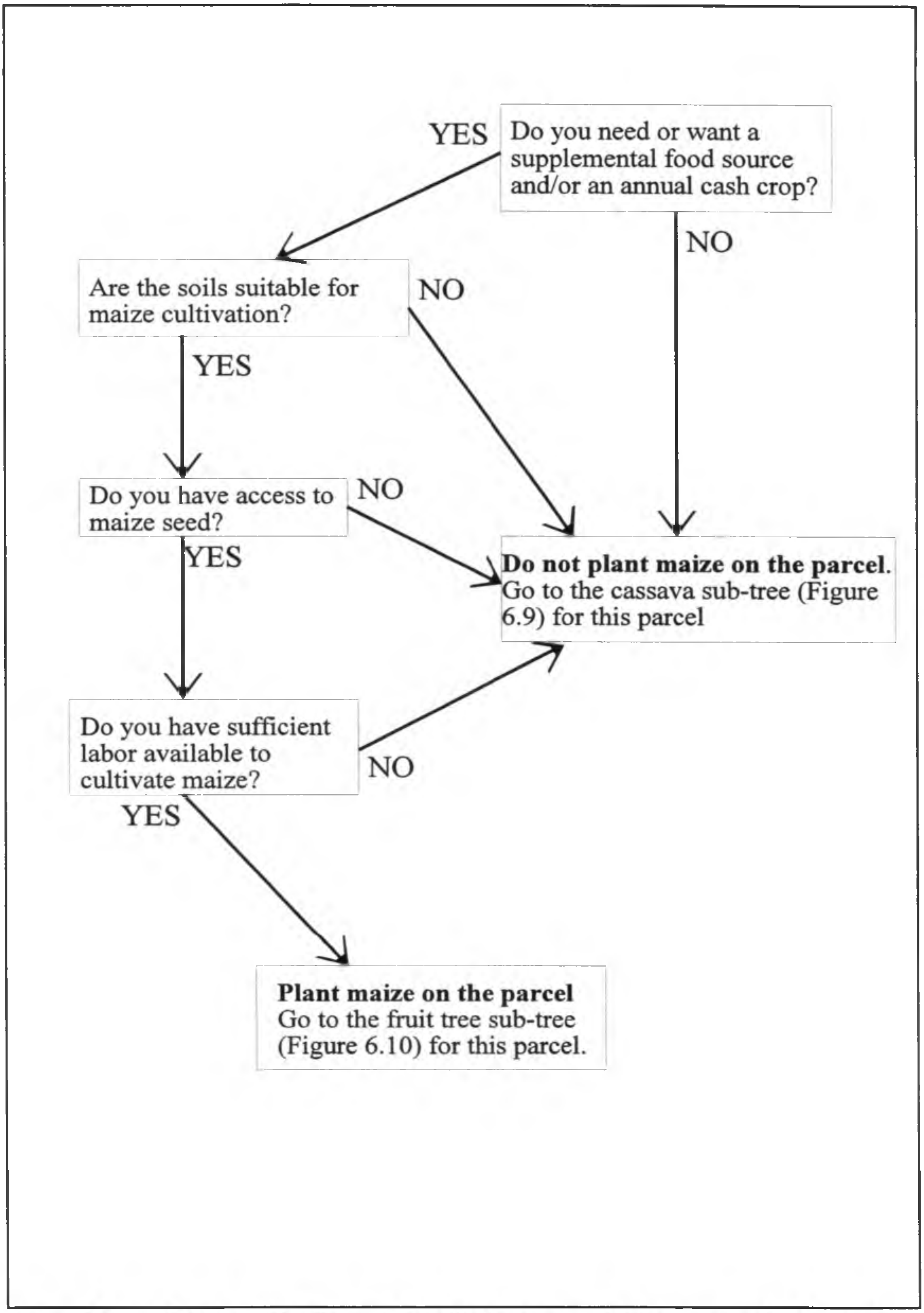


Figure 6.8. Maize cultivation sub-tree for Imbarasan / Himamara upland parcels

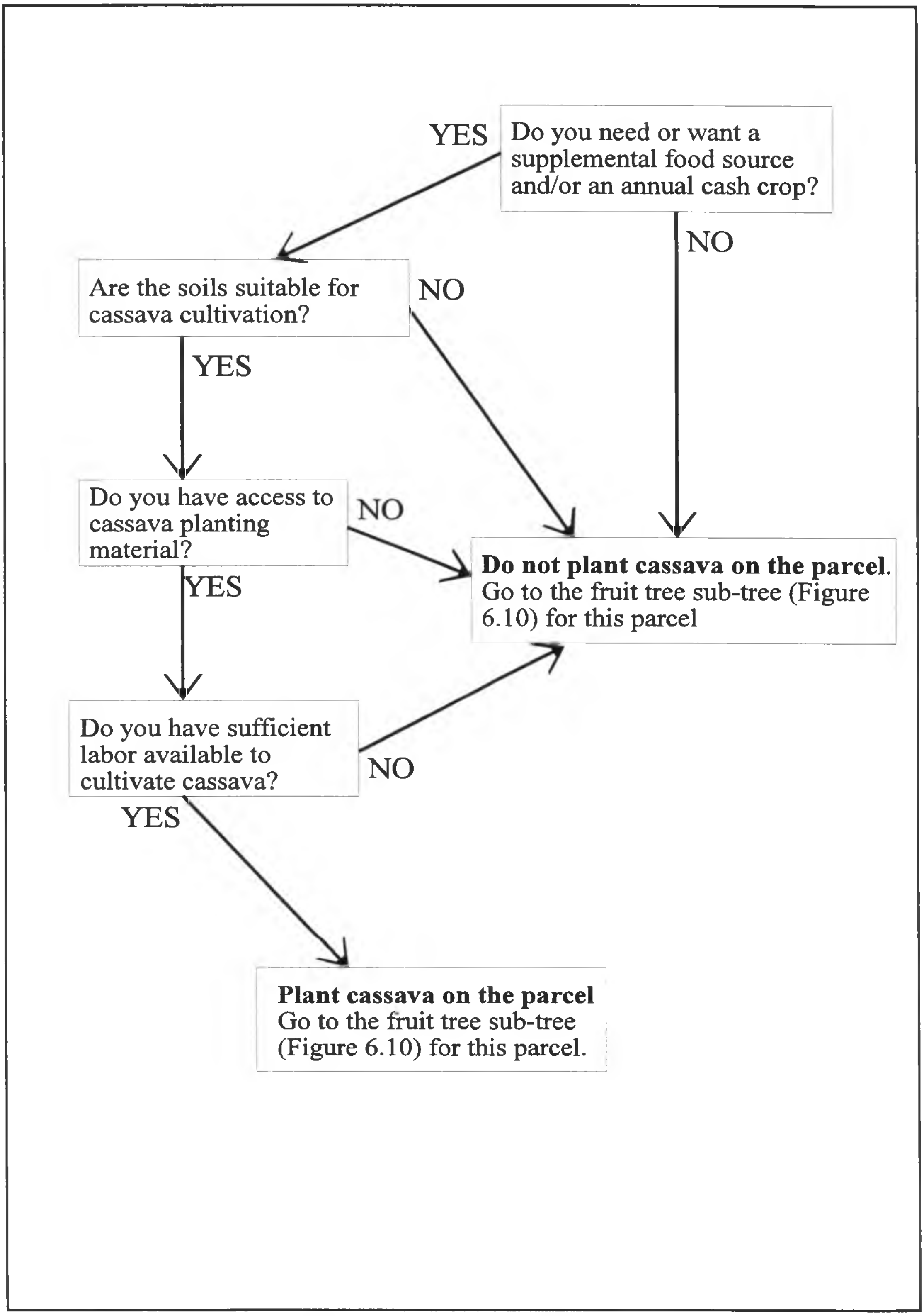


Figure 6.9. Cassava cultivation sub-tree for Imbarasan / Himamara upland parcels

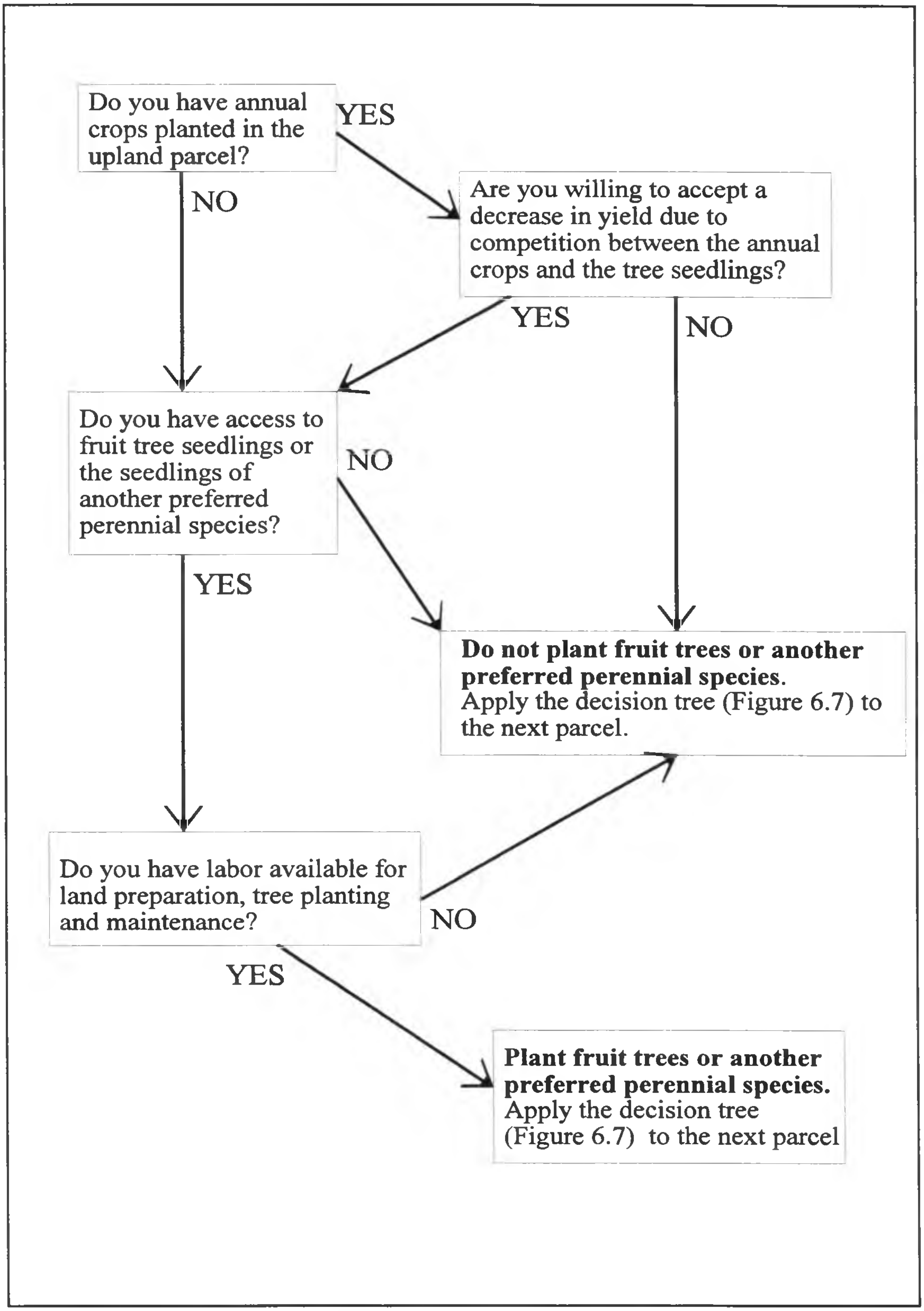


Figure 6.10. Fruit tree cultivation sub-tree for Imbarasan / Himamara upland parcels

particularly for weed management. In addition, if the trees were planted more than one or two years earlier, residents generally believed that they would compete with the annual crops and so usually left the area as a managed or semi-managed orchard. If the land clearing and maintenance conditions for annual crop cultivation were met, residents generally planted rice (Figure 6.11), maize (Figure 6.8), cassava (Figure 6.9) or any combination of these three species.

For parcels that were not cropped during the preceding rainy season, the first management criteria used by residents was the productivity of the current fallow vegetation. If the fallow was highly productive (e.g. banana or other fruit tree orchard), this area was not cleared for annual crops and the household lived on the proceeds from the perennial species. If the fallow vegetation was not highly productive, the second decision criteria was the length of the fallow period. The preferred fallow cycle in the area was 7-10 years. If they had other land available, residents preferred to maintain this long fallow rotation. If less land was available, a shorter rotation was used. The remainder of the decision process followed the same sequence as for previously cropped parcels (Figure 6.7) starting with the consideration of whether or not fruit trees are present on the parcel.

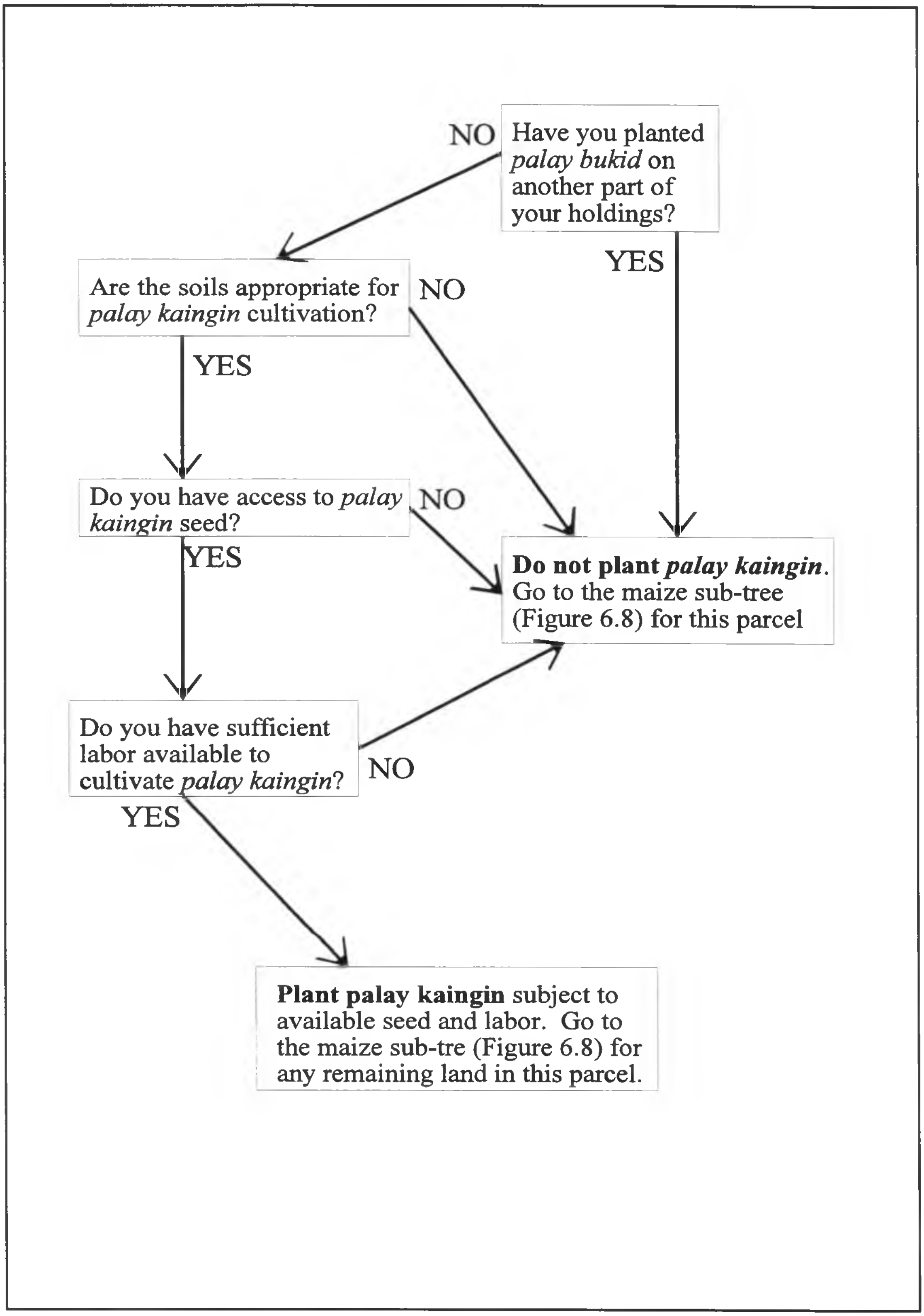


Figure 6.11. Rice cultivation sub-tree for Imbarasan / Himamara upland parcels

Halang

The third management decision model simulated household decision making for upland management in Halang (Figure 6.12). Residents of Halang managed their upland areas in order to meet multiple goals; however, as described in Chapter 4, most households put a priority on production of crops for sale. Residents only planted crops for one season due to the lack of water in dry season. Overall, residents reported six different potential upland uses: taro cultivation, upland rice cultivation, maize and peanut cultivation (in sequence), fruit trees (highly managed fallow), semi-managed fallow and non-managed fallow.

The first decision criteria used by Halang residents was the present land use of the parcel of interest. If the parcel was currently not planted to annual crops, residents then assessed the length and current productivity of the fallow parcel. In order to return a parcel to annual production, residents preferred a fallow period of at least three years. However, if the fallow vegetation was highly productive (e.g. fruit trees) then the area was usually left fallow. However, if the fallow period was not highly productive, and labor for land clearing was available, taro was the preferred crop on these newly cleared parcels unless their were other constraints to taro production such as planting material availability (Figure 6.13).

If the parcel was currently cropped with annuals, the second major decision criteria was the crop planted in the past cropping season. If ample land was available,

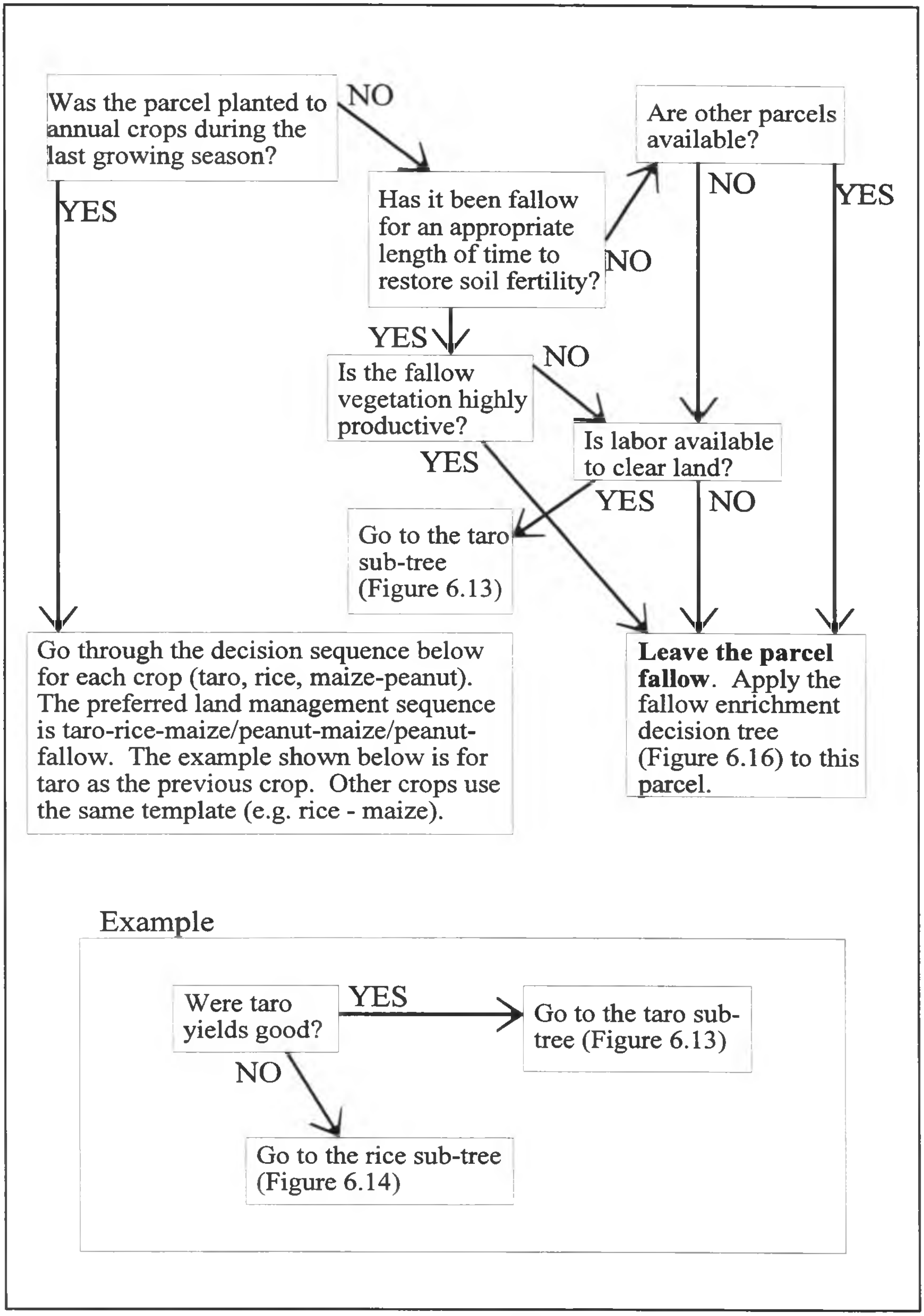


Figure 6.12. Main decision tree for Halang upland parcels

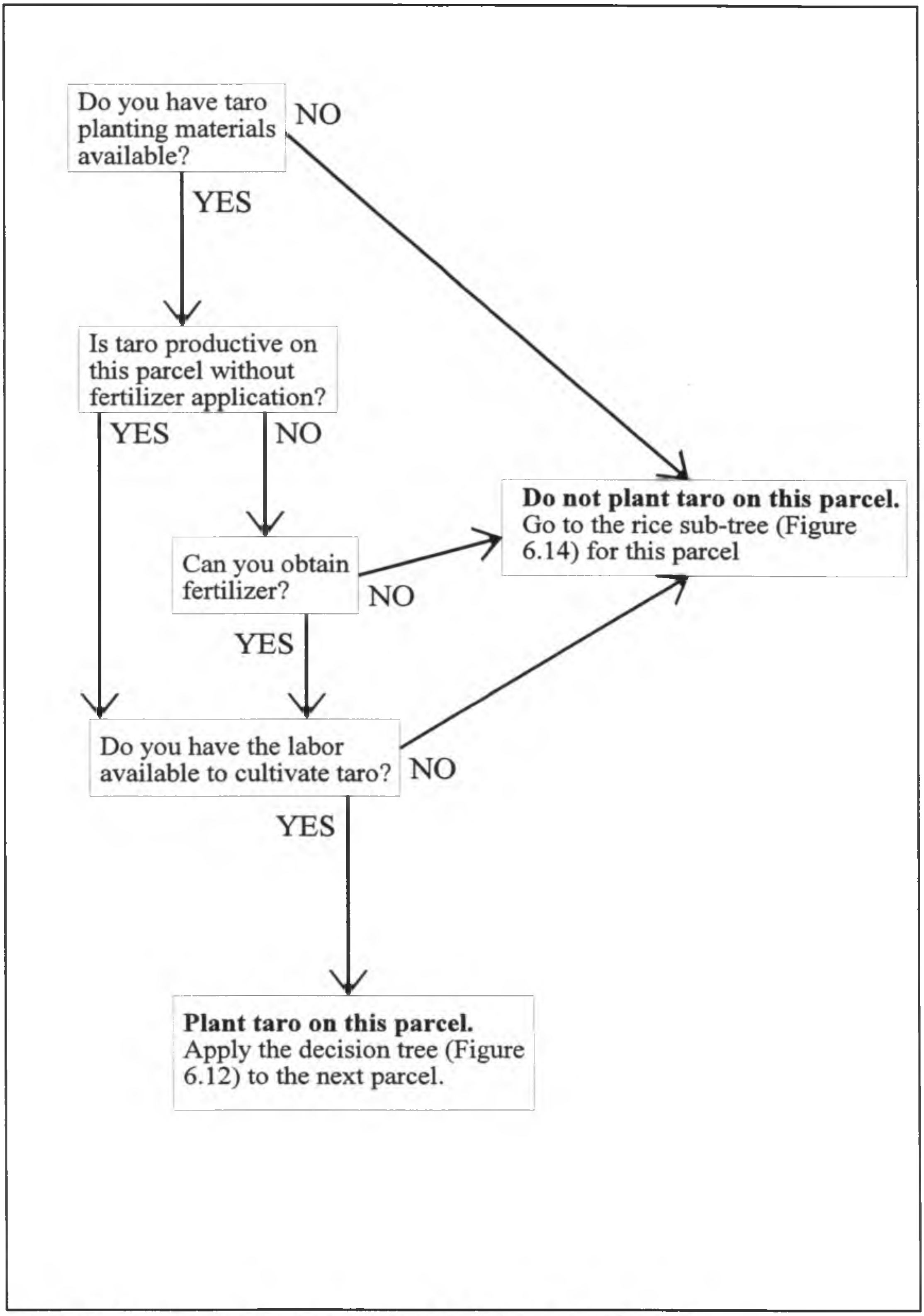


Figure 6.13. Taro cultivation sub-tree for Halang upland parcels

most residents preferred to use a system where taro was planted in the first year, rice in the second year, and a maize followed by peanut (or peanut followed by maize) was planted in the third and fourth years. The parcel was then returned to fallow. Depending on the availability of planting materials and labor and the household's risk perceptions, the fallow may have been enriched with fruit or forest trees (Figure 6.16). However, this sequence was altered depending on crop yields from the past cropping season, limitations to cultivation of specific crops such as lack of planting materials or labor (Figures 6.13, 6.14, 6.15), and overall land availability.

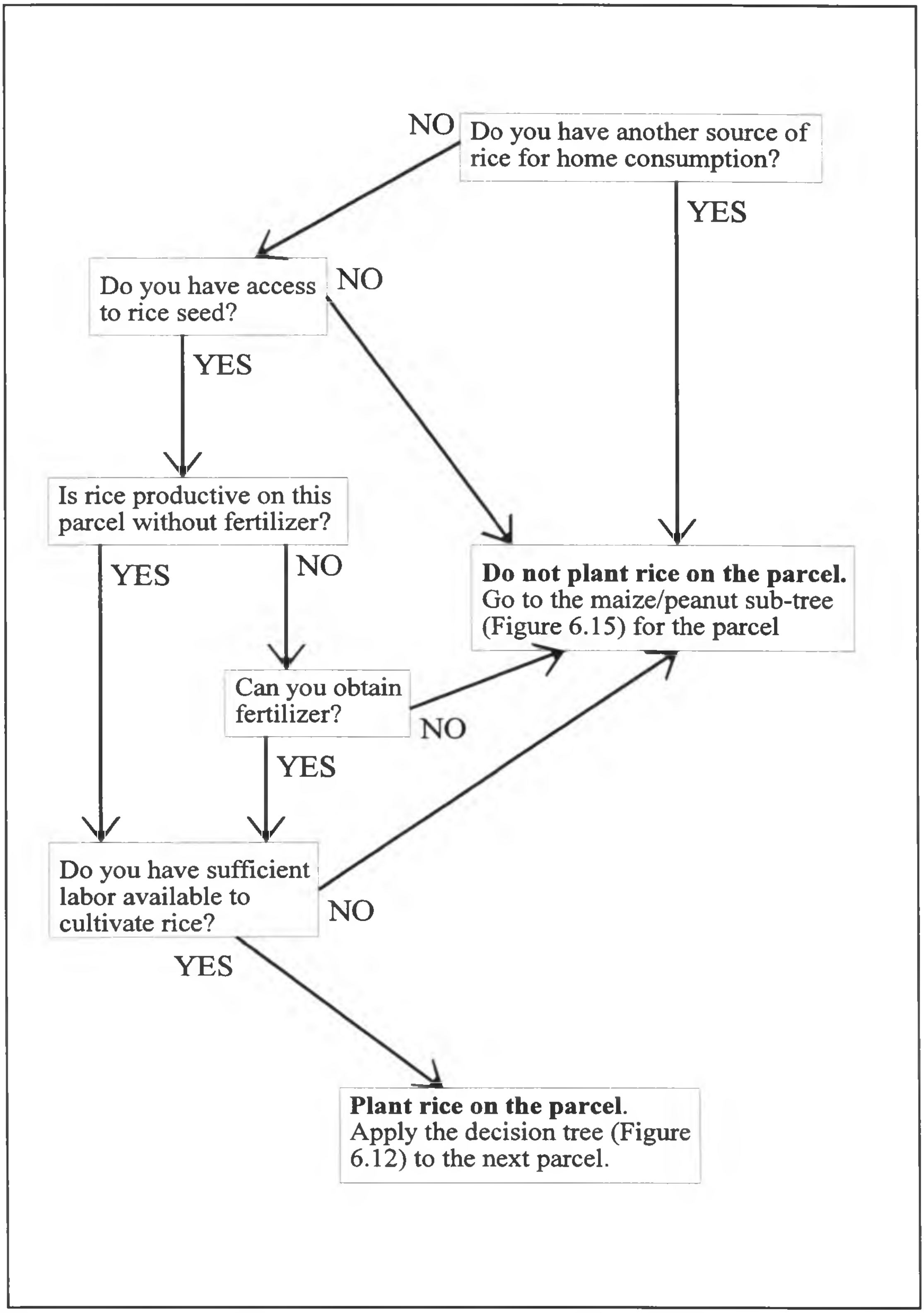


Figure 6.14. Rice cultivation sub-tree for Halang upland parcels

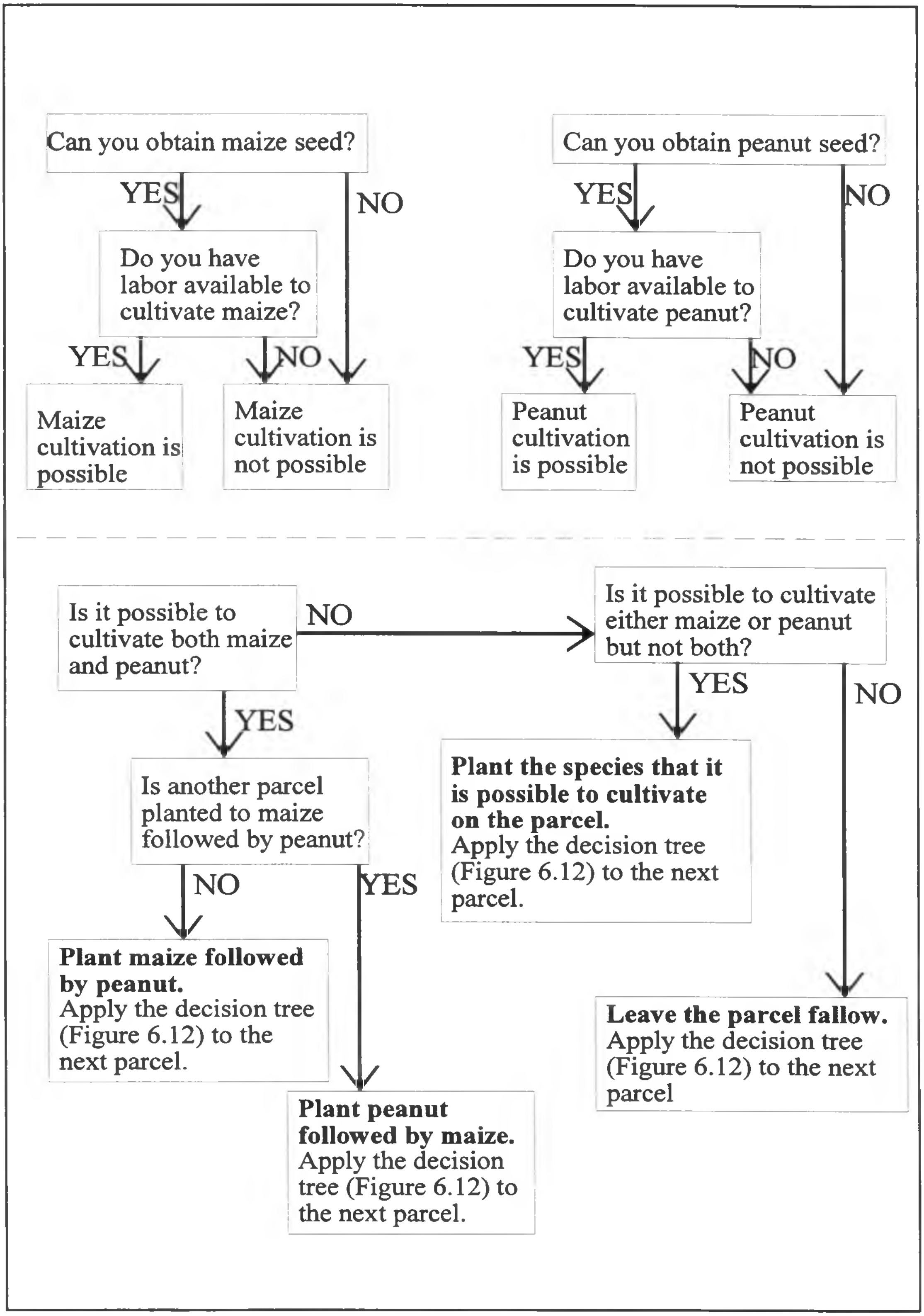


Figure 6.15. Maize / peanut cultivation sub-tree for Halang upland parcels

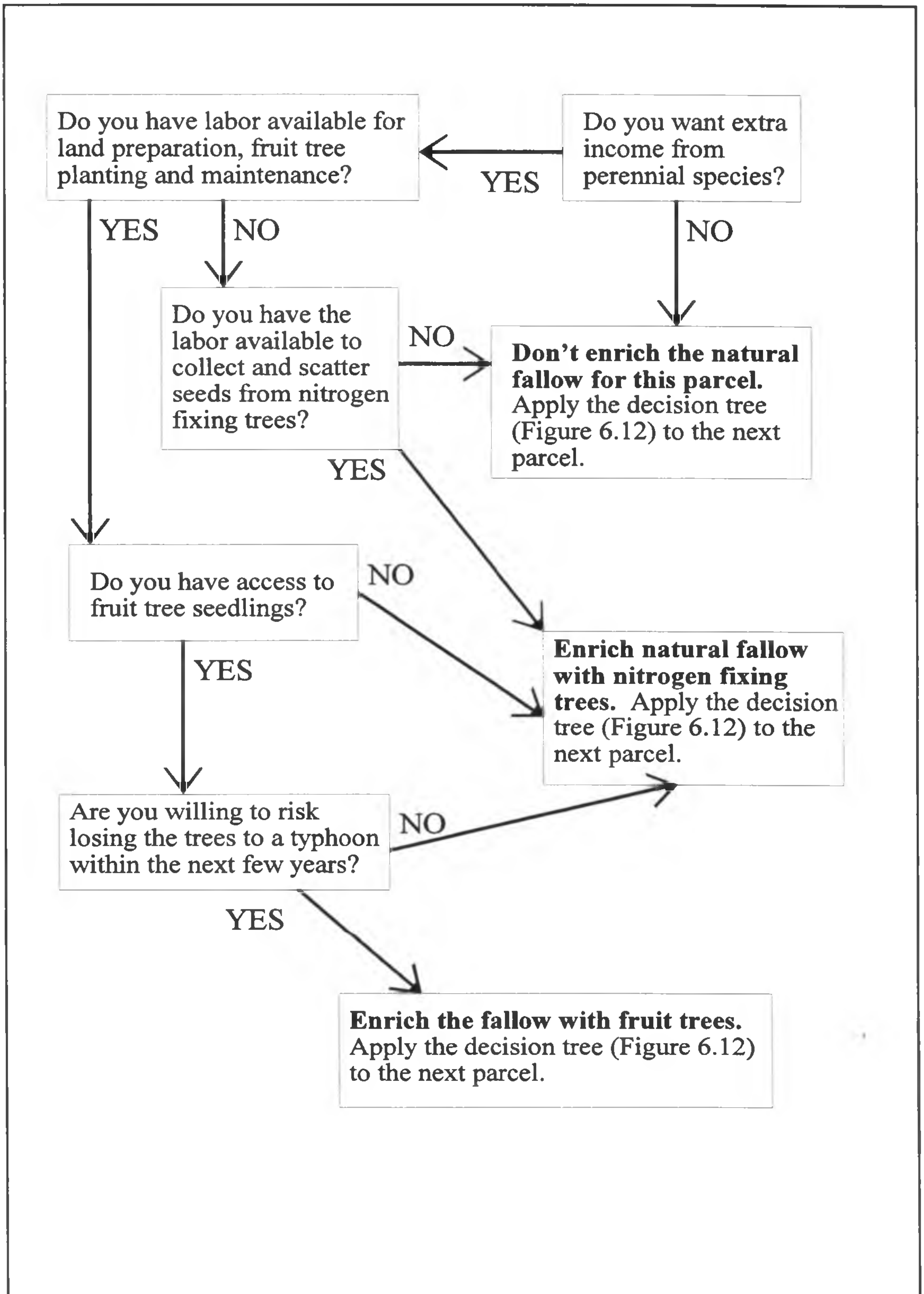


Figure 6.16. Tree cultivation sub-tree for Halang upland parcels

Upper Magsaysay

The fourth management decision model developed for this study simulated household decision making for upland management in Upper Magsaysay (Figure 6.17). Residents of Upper Magsaysay managed their upland areas in order to meet multiple goals; however, their primary management goal was subsistence production. Residents reported four different potential upland uses: upland rice, other relatively acid-soil tolerant annual and biennial crops (cassava, pineapple, ginger and/or taro usually inter-planted), semi-managed tree orchard (usually coconut), and non-managed fallow.

As in the previous cases for Imbarasan / Himamara and Halang, the first decision criteria used by Upper Magsaysay households was the current land use. According to local residents, local soil conditions made this the primary determining criteria for annual crop based systems. Households preferred to clear parcels that had been fallow for at least 7-10 years. The first crop planted on newly cleared parcels was upland rice, barring seed and labor constraints (Fig 6.18). Residents indicated that rice yields decline precipitously after the first year of cultivation. As a consequence, parcels cropped to rice were planted to an inter-crop of one or more relatively acid soil tolerant annual and biennial crops including cassava, pineapple, ginger and taro depending on individual crop constraints (Fig 6.19) and household preferences. These crops were maintained, either as rattoon crops (pineapple), or through replanting until yields start to decline when the land was allowed to return to

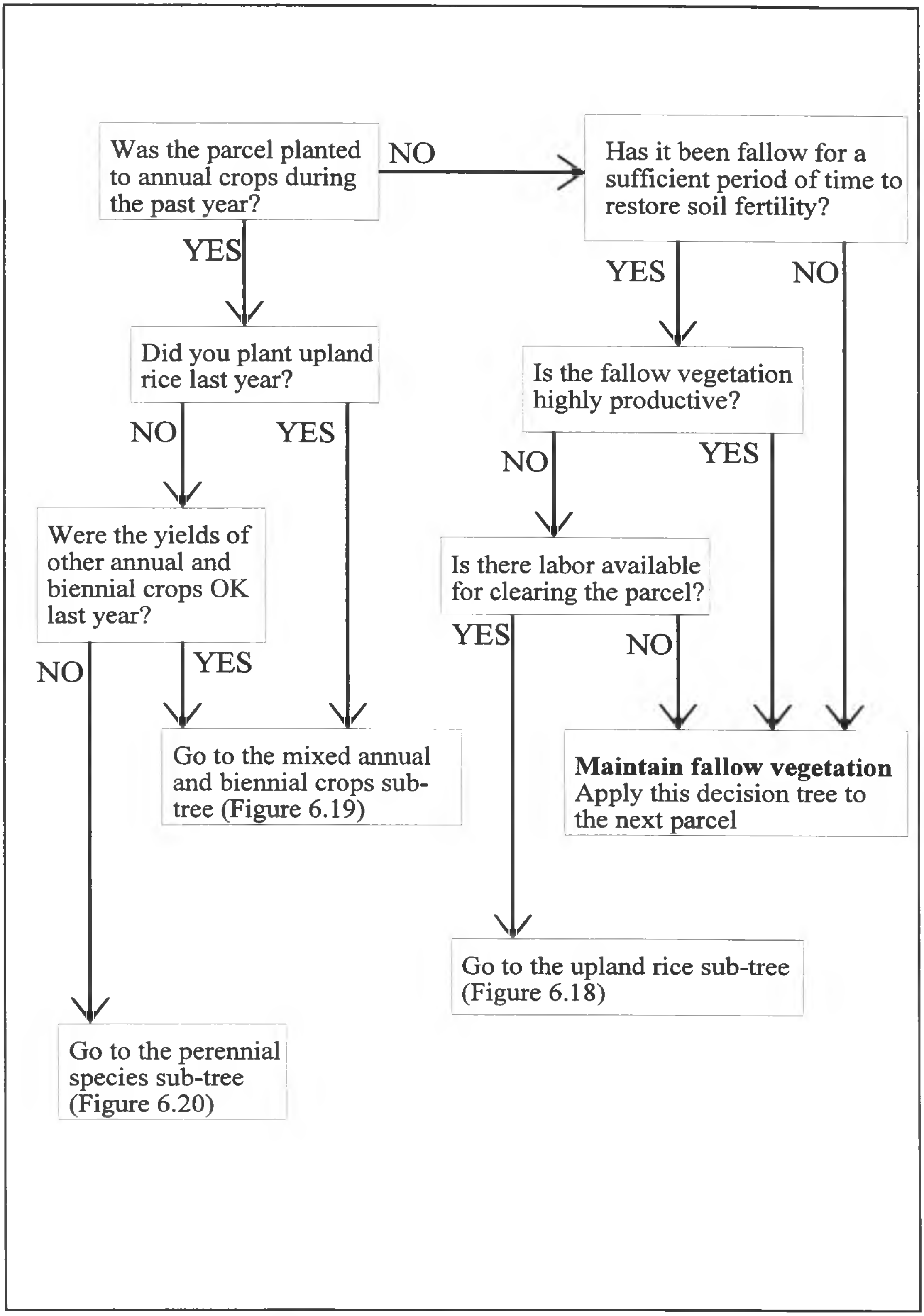


Figure 6.17. Main decision tree for Upper Magsaysay upland parcels

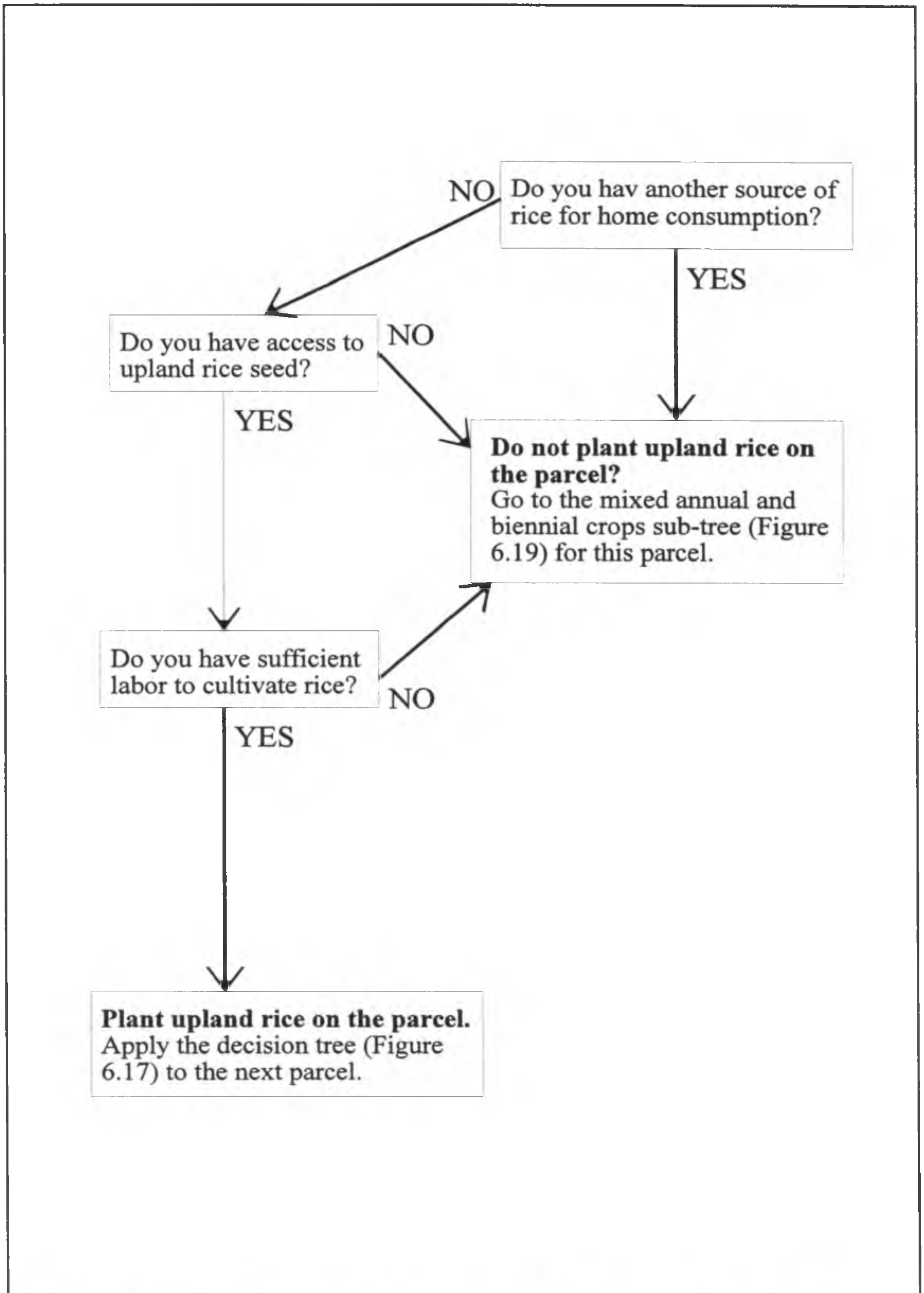


Figure 6.18. Rice cultivation sub-tree for Upper Magsaysay upland parcels

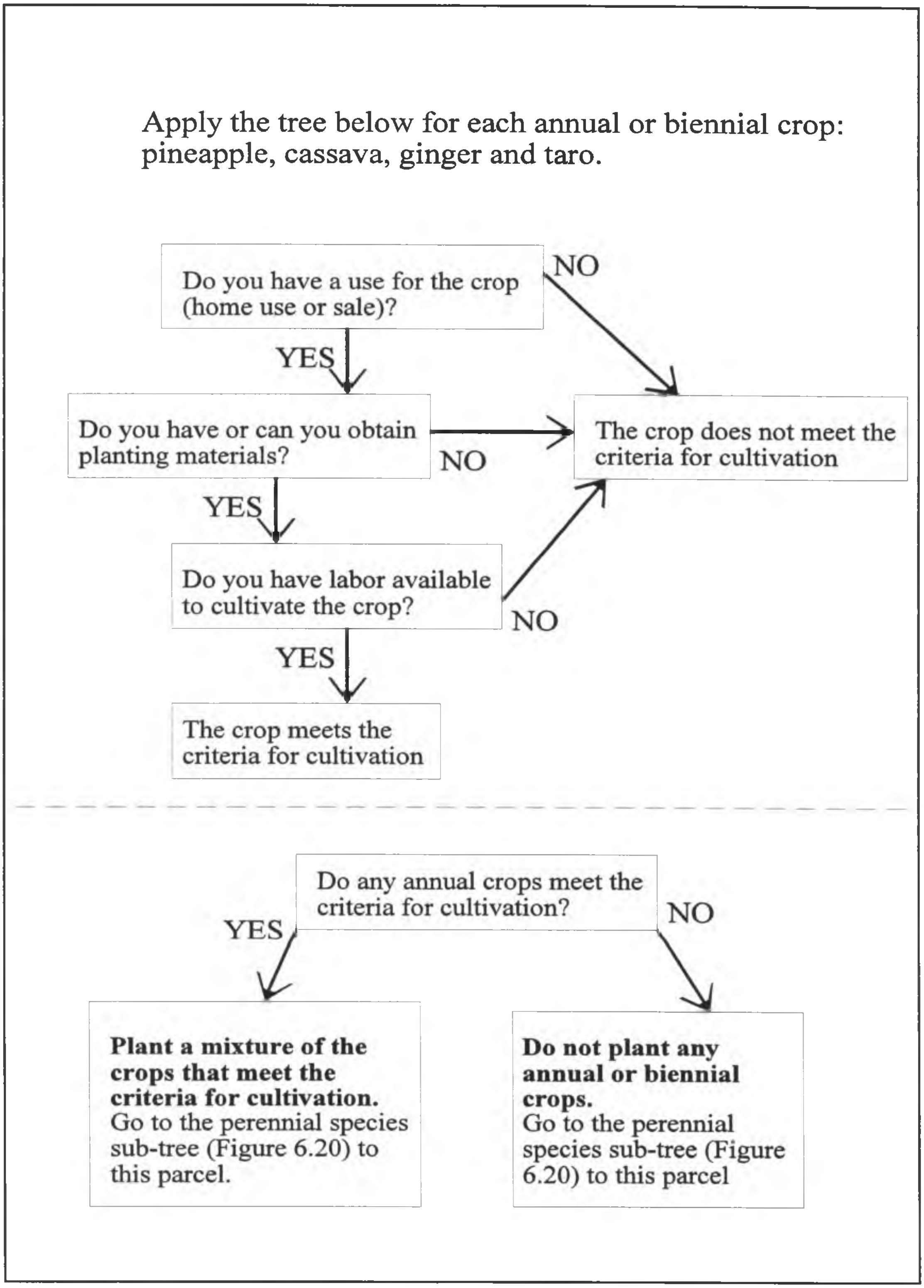


Figure 6.19. Annual and biennial crop cultivation sub-tree for Upper Magsaysay upland parcels

fallow. If planting materials and labor were available, this fallow was enriched with fruit trees (Figure 6.20) including coconut and citrus. However, with the collapse of the copra market several years ago, fewer residents reported planting coconuts.

Discussion

The four decision trees presented in the previous section provided general representations of household land management decision making in the three communities. In this section, I discuss some of the common factors found in the decision trees as well as some of the differences between the decision models. The section concludes with some general insights derived from the decision models.

Common factors

A number of common factors were apparent from an examination of the four decision trees. Three of the four models included consideration of the present land use on the parcel and on other parcels. Other common issues considered at some point in all four decision trees included environmental constraints (water availability, land availability and soil properties), labor availability and the availability of planting materials.

Differences between the models

Even though there were a number of common factors in the four decision trees, there were also significant differences between the four models. The first important difference between the management decision making models was in the overall household goals. Raising crops for subsistence production was the primary

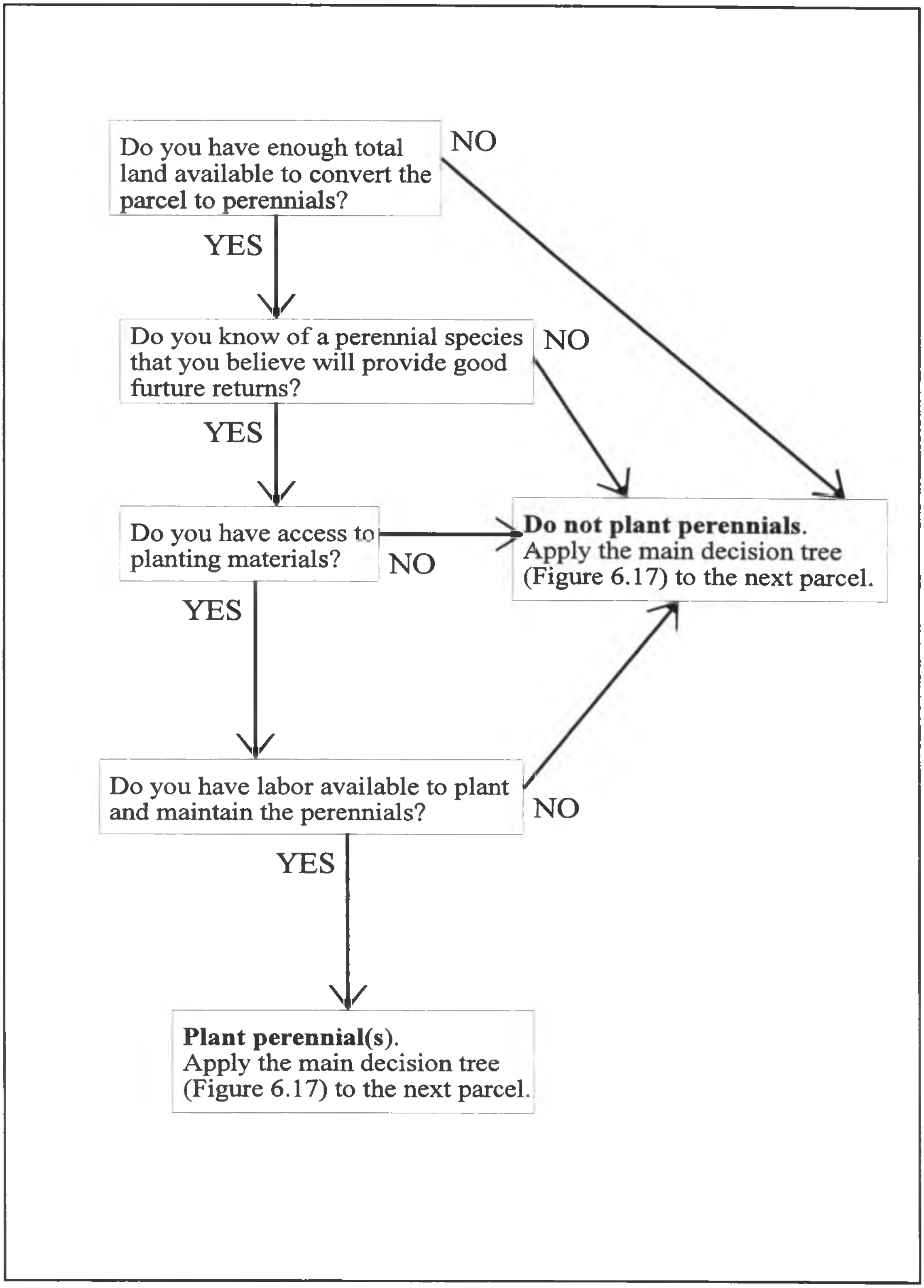


Figure 6.20. Perennial species cultivation sub-tree for Upper Magsaysay upland parcels

goal for households in Upper Magsaysay (Figure 6.18) and for upland households without lowlands in Imbarasan / Himamara (Figure 6.7) while it was a secondary goal for households in Halang (Figure 6.12) and for households in Imbarasan / Himamara that have lowlands (Figures 6.1 and 6.7). In contrast, production for cash income was the primary household goal in Halang and for the majority of households in Imbarasan / Himamara that have lowland holdings.

The second, community and land-type specific difference between the models was the range of management options that residents perceived were available to them. The overall list of available options for each decision tree appeared to be governed by an interaction between environmental constraints (water, soils) and the availability of infrastructure and markets. For example, the interaction between the strongly acid soils found in Upper Magsaysay and the lack of infrastructure to facilitate the availability of liming materials effectively limited management options in the area to rice in newly cropped areas and acid tolerant annual crops elsewhere.

The third difference between the four decision trees was the relative importance of the various common factors discussed in a previous section. Decision making for dry season management of Imbarasan / Himamara lowlands (Figure 6.1) was primarily driven by water availability. In contrast, land availability and labor availability for land clearing were the major determinants of management decision-making in Upper Magsaysay and in Halang. Decision making for upland management in Imbarasan / Himamara was similar to the other two upland systems;

however, the availability of lowland parcels was generally considered before land and labor availability.

General insights

Taken as a group, the four decision trees may provide some general insights into upland decision making in similar Philippine communities. First of all, all of these models illustrated that upland residents generally managed their lands to meet multiple goals. Although one of these goals was often subsistence production, producing items that can be sold for cash was also important. The relative importance of subsistence production compared to production for markets appeared to depend primarily on the availability and marketability of a saleable product as well as the relative productivity of the primary subsistence crops. In Halang, the combination of low subsistence crop yields, a viable cash crop (taro) and the marketing infrastructure resulted in management systems dominated by production for sale. In Upper Magsaysay, yields of subsistence crops were very low; however, the lack of marketing infrastructure and the low prices afforded to potential cash crops (e.g. pineapple, coconut), led to management systems dominated by subsistence production with a only small amounts being sold. In Imbarasan / Himamara, households with *bukid* suitable for rice cultivation were more likely to choose dry season and upland management strategies that provided cash income; however, poor infrastructure and small markets limited management options. Households without *bukid* generally focused on management strategies for subsistence production.

These results suggested that upland households were willing to adopt management strategies that did not result in household production of subsistence food supplies as long as they were reasonably certain that the production strategy would generate sufficient income to purchase food. However, they also suggested that, all other things being equal, households generally preferred to produce at least a portion of their subsistence food needs. Virtually all households in all three communities grew at least one crop (rice, maize or cassava) that could be consumed or sold.

Closely related to the idea of households having multiple management goals, these results showed that households, at least in these three study communities, also used a variety of management strategies and were involved in a variety of enterprises to help them meet their goals. Typical households in all three communities had at least 2 or 3 species of annual crops. Most households in Imbarasan / Himamara and in Halang had some type of livestock and even in Upper Magsaysay, where livestock were much less common, most households raised chickens. Most households in all three sites made use of some perennial species either from their own holdings or from common lands. Households also had multiple sources of income. In Imbarasan / Himamara and Halang, off-farm income, usually from day-labor in agricultural tasks, was very important. In Upper Magsaysay, the harvest of forest products (timber and rattan) filled this cash generating role.

The results from the study communities suggested that upland dwellers in general, even former lowland residents now living in the uplands, have developed diverse and varied management systems. As a result, interventions, including both government programs and policies as well as the activities of non-government organizations and other groups, should investigate how changes proposed for one aspect of these management system may potentially impact other parts of the systems.

The third important insight that came out of the analysis of the four decision trees was the strong determining role played by labor availability in household land management strategy choice. Unlike many more intensively studied areas in the developing world (e.g. Java, Indonesia; many parts of India; the central plain of Luzon in the Philippines), labor in the three study communities was a limiting resource. The amount of land residents could manage and the mix of components that they could incorporate into their household management system was often limited by the amount of labor available. Studies in more homogenous upland communities (e.g. "tribal groups" in the Philippines) have documented a wide variety of community based cooperative management strategies to address the labor issue. However, in the three communities included in this study, cooperative labor sharing arrangements were uncommon and households were generally dependent on the labor available from their immediate family.

Although I only have evidence from these three communities, I believe that these labor issues are common in other, migrant-dominated upland areas. There are several reasons for this supposition. First of all, first generation migrants generally claimed comparatively large holdings. As a consequence, the person-land ratio in these areas was generally low and consequently, labor was potentially scarce, especially at times of peak demand. Secondly, members of relatively new communities were unlikely to have the shared history, social cohesion and mutual trust that formed the basis for many labor sharing arrangements. The situation in Halang, however, suggested that this was not the only issue. Virtually all Halang residents migrated from the same village; however labor sharing arrangements were no more common there than in the other two study sites.

A possible alternative explanation from the lack of shared history was that upland areas are generally managed in small, often scattered parcels. Having a large group of people did not confirm a significant advantage for many management tasks in this type of situation. I deduced another alternative explanation for the lack of shared labor arrangements from information given by residents and my own observations of labor use for *palay bukid* planting in Imbarasan / Himamara. In that community, planting rice on other people's land had become a significant source of relatively scarce cash income at a time, planting season, when cash was needed, especially for school expenses, but cash was generally scarce. Given existing credit arrangements, households could obtain credit (against estimated rice production) to pay laborers (in cash) to plant. So, a labor pseudo-exchange system (based on cash) had replaced strict barter-based labor exchange arrangements.

The fourth and final general insight generated from the four decision trees was the mutual and interacting influence of both bio-physical and socio-economic factors on land management decision making. In all the decision trees, one or more bio-physical factor was important including water availability in Imbarasan / Himamara dry season lowlands and soil fertility in all three upland decision trees.

Decision cases for systems with strong perennial component

A number of studies, including this one, have shown the relatively low productivity of annual crop production in these upland areas. In addition, annual crop production on sloping lands has been associated with negative environmental effects including soil erosion that may have adverse impacts beyond the individual field or household land holdings. A shift to management systems based on perennials has been suggested as a more environmentally sound and potentially more productive option (at least over the long term) for upland areas. As a consequence, in this second section of the chapter, I present brief case studies of the decision making process used by seven households who have developed or are developing management systems with a significant perennial component. The section concludes with a discussion of some of the important factors that could be gleaned from an examination of these seven households that may provide a basis for further generalization.

Case 1 (Imbarasan / Himamara)

The first case study household was located in Imbarasan / Himamara. Perennials had the potential to become a significant portion of the household livelihood system. The household was a young family with small children. At the time of the study, the husband provided the only source of household labor and invested most of his time and energy in managing a small area of irrigated lowland. However, he was developing three hectares of upland into a perennial orchard dominated by cashew. He cited three conditions that had led toward his development of this orchard system: 1. He did not need this land for annual crop production, 2. Seedlings were available, and 3. He had observed that the soils were poor for annual crops. Because of the labor shortage, the household was not managing the trees intensively, but hoped to manage them more intensively and to make them a greater part of the livelihood system in the future.

Case 2 (Imbarasan / Himamara)

The second case study household was another young family with small children. Perennials were a small part of the present household livelihood system but the household hoped that perennials, especially mangos, would become an increasingly important part of their system in the future. The household obtained a small parcel of land in Imbarasan / Himamara and initially attempted to manage it using a *kaingin* strategy dominated by maize cultivation. However, they observed that the soils were very poor for annual crops. The household has a long time horizon and a desire to stay on the land. As a consequence, they tried several different perennial species. They had drought trouble with bananas, but were optimistic about the potential of cashew and particularly of mango.

Their optimism about the potential for mango was based on observations of successful mango growth on a small plantation in the area with soils that they believed were similar to the soils on their land. They purchased mango seedlings when extra money was available and intended to continue that practice. Although they were growing annuals on a portion of their land, they hoped to eventually convert the entire area to orchard.

Another interesting point about this household was that, unlike many other residents who had chosen to plant the *kalabaw* mango variety that was grown primarily for the high value, ripe, fresh market, they preferred to plant the smaller *pico* variety that was primarily sold as green mango. Their rationale for this decision was that, even though the *pico* mangos commanded a lower price in the market, they were much less likely to be damaged in difficult transit from their holdings to the market in San Jose so the total returns from production were likely to be greater than the higher priced but more fragile *kalabaw* mangos.

Case 3 (Imbarasan / Himamara)

The third case study household also lived in Imbarasan / Himamara and had shifted to a management system based on the cultivation of gmelina trees for timber production on most of their upland land holdings. They had managed their holdings, approximately 2 hectares, for approximately 15 years using a shifting cultivation system with maize, upland rice and cassava as the primary crops. However, in the late 1980's, they became very interested in the possibilities for timber production as an alternative to the poor annual crop yields on their holdings. They initially obtained gmelina seedlings from a government sponsored nursery in the area and planted the first trees on their holdings in 1989. By the time of this study, these trees were producing seed and they had begun to propagate their own seedlings and to slowly convert their holdings to managed timber plots.

They were operating on a long time horizon and it was very important for the husband and wife to leave something productive for their children. Annual crops did not allow them to do this. They completed the switch to a primarily tree-based system in 1996 because the husband obtained employment as the manager of a small tree plantation in an area near Imbarasan / Himamara. Their locally perceived expertise (particularly the wife) in gmelina seedling propagation was part of the reason that they got the job. This job provided them with cash income and access to a small area of lowland where they could grow rainy season rice and dry season mung bean. So, they did not have to rely on the upland parcel to provide their food needs.

Case 4 (Imbarasan / Himamara)

The fourth case study household, also located in Imbarasan / Himamara, had developed a livelihood system that was based exclusively on the cultivation and sale of bananas. The household had developed the system over time and had steadily expanded the portion of their land holdings planted to bananas. They had reasonably large holdings (7 hectares) and so had been able to plant over 4 ha exclusively to bananas. In the past, the remainder of their land holdings had been used for shifting cultivation of maize and rice. However, by 1996, they had shifted exclusively to perennials. All of their children had left home and the household included only a couple in their 60's. As a consequence, labor was in short supply. However, they also had low cash needs. So, they found the banana system to be a good fit. Bananas provided modest but consistent returns throughout the year and required a limited amount of labor.

Case 5 (Imbarasan / Himamara)

The fifth case study household, also in Imbarasan / Himamara, was just starting to develop a perennial component to their overall livelihood strategy. This household had *bukid* holdings and was starting to plant and manage increasing amounts of bamboo on their adjacent upland holdings. Since they cultivated *palay bukid*, they did not need to use the uplands for food production. They observed a lucrative and growing market for bamboo in the San Jose area and hoped to take advantage of this market by starting to intensively cultivate bamboo. They developed a proficiency at bamboo propagation and raised their own planting materials (cuttings). At the time of this study, they had planted several hundred cuttings on their upland holdings and intended to continue to plant. They indicated that they expected to be able to harvest marketable bamboo from the new clumps after three or four years.

Case 6 (Halang)

The sixth case study household, located in Halang, developed a management system that was based almost exclusively on the cultivation of leucaena (*Leucaena leucocephala* (Lam.) de Wit), locally known as *ipil-ipil*, for cattle fodder and charcoal. When they first arrived in the area, they used a management system based on annual cultivation. However, since they had several children and education was a priority for the household, they needed significant cash income. They obtained this income largely through charcoal production. In addition to the need for cash income, they observed that the returns to labor for annual crop cultivation dropped significantly as the originally fertile soils in the area were degraded. Since they had one of the largest holdings in the area, they were able to devote a significant area to nitrogen fixing trees managed for charcoal.

At this same time, with the income from annual crops and charcoal, they were able to invest in cattle. The *ipil-ipil* trees provided an increasingly important source of cattle fodder. As their children grew older and left home, the household became increasingly short of labor and shifted more and more toward a less labor demanding system based on charcoal and cattle fed primarily on leucaena. As part of this shift, they started to convert increasing amounts of their land to managed forest. In 1996, only three people remained in the household (an older couple and their adult son) and their entire livelihood system was based on cattle and trees.

Case 7 (Halang)

The seventh case study household, also located in Halang, had a mixed livelihood system that includes annual crops, cattle and a significant perennial crop component including both fruit and forest tree species. This household originally used the typical short-fallow rotation annual crop system described earlier for Halang and continued to use this system on part of their land. However, very early in their residence in Halang, they started to plant increasing numbers of perennials including both fruit and forest trees. They had a large parcel were able to devote land to perennial production. In addition, the head of the household placed a high value on land itself and took a long term view of land productivity. For example, during the study, he was very proud of the fact that he was building his new house largely out of lumber from trees he had grown on his land and was quick to point out that he had already planted trees to provide the timber for his next house ten or more years in the future. Another reason that this household, unlike many other households in Halang, had invested significantly in perennials, especially fruit trees, was that the household land holdings were located on the leeward side of a large hill in the area effectively protecting them from damage from the not-infrequent hurricanes.

Important factors

Based on the seven cases described above, there were a number of different factors that influenced a given households decision to incorporate a perennial species as a major component of their livelihood system. These included factors related to land holdings (size, soils, location), socio-economic variables(infrastructure, markets), and household attributes (labor availability, household needs and goals, outside income).

The first group of important factors from the seven decision cases were those factors related to land. First of all, several of the cases (number 1, 4, 5, 6 and 7) had ample land available either to develop an extensive management system (bananas in #4, lucaena/cattle in #6) or to incorporate both perennials and annuals into their management system (#1, #5 and #7). Another important land related variable was the soils. Households 1, 2, 3 and 6 all indicated that their land, or the portion of their land planted to perennials, had soils that were better suited to perennial cultivation than to the cultivation of annual crops. This was a particularly important determinant in three of the Imbarasan / Himamara households (#1, #2 and #3). The third factor related to land was location. This was a particularly important determinant in Halang, where household #6, whose holdings were located on the leeward side of a large hill, had a very different, and much more favorable, attitude toward fruit tree cultivation than that of his neighbors located on the top and windward sides.

The second set of factors that were important in most of the seven household decision cases were factors related to the socio-politico-economic situation including infrastructure, markets, and prices for perennial products. All seven of the decision cases included consideration of one or more socio-politico-economic factors. Infrastructure and the ability to transport the products produced by or from upland perennials were mentioned as an issue for household #2 (switched to a lower value but more easily transported variety), household #4 (cited the transportability as a plus for banana cultivation), household #5 (bamboo was easily transported) and #7 (charcoal could be transported out of the area to market). All households mentioned that the existence of markets or the belief that markets will exist was part of their decision to plant perennials. Good prices available in the market provided an additional incentive especially for the bamboo-based system that household #5 was starting to develop.

The third set of factors that were important in the decision cases were factors related to the households themselves. These included labor availability, household needs and goals, and outside income. Several households mentioned that the switch to perennials involved consideration of labor availability. In two cases (#4 and #6), the lack of available labor has helped to push the households toward extensive management systems with relatively low labor requirements. Labor was less of an issue in the other five cases; however, the lack of labor had adversely affected household #1's management of their cashew trees, and had limited the extent of perennial cultivation by household #2 up to the time of the study. In contrast, household #3, #5 and #7 had been able to take advantage of available labor resources to develop systems that incorporate both perennials and annuals.

Household needs and goals also strongly influenced all of these decision cases. In several cases (#1, #2, #3, #7), one of the reasons that households had developed perennial-based management systems was because these systems provide future production to support their children. This was likely to be part of the reason behind household #5's development of a bamboo-based management system; however they did not say so explicitly. The level of household needs was also important, for household #4 and household #7, extensively managed systems provide for the low level of basic needs for the household. This was particularly true for household #4. In contrast, other households (especially #1, #2, #3, #6) saw perennials as a potential way to generate cash for future household expenses such as education for children or retirement or as a way to avoid future expenses such as home construction (#6).

The last important household factor that appeared to facilitate the switch to systems based on perennials was the presence of an outside source of income. Two of the three cases where households had switched completely to perennials (#3 and #6) had outside income available. The head of household #3 had obtained a job managing a tree plantation and household #6 received money from children working in Manila. Other residents in both communities mentioned the maturation time for perennials where they were not producing saleable products as a significant constraint to their incorporation of perennial species into their management system.

Two other factors that have been generally believed to influence household adoption of management strategies based on perennial species did not come out in this study. They were the role of land tenure status and species availability. In the case of land tenure, residents in both Imbarasan / Himamara and Halang generally believed that they had secure tenure to their parcels. As a consequence, tenure was not an issue. Since I spent less time in Upper Magsaysay and perennial-based management systems seemed less common there, I was unable to indentify a case study household that was using a perennial-dominated system. One of the reasons for the low emphasis on perennial management in Upper Magsaysay may be the unclear tenure status for most parcels in that community. The second issue, species availability, also did not come up explicitly in the case studies but is a potential issue. Imbarasan / Himamara and Halang both have climates characterized by long dry seasons. During this study, residents in both areas indicated that they felt that their fruit tree options were limited to mango and cashew because these species show good drought tolerance. Residents were generally unaware of other species that could potentially be productive in these environments. A similar situation was apparent in Upper Magsaysay where coconut was the dominant species and frequent typhoons the dominant stress. Although coconut was seldom severely damaged by all but the highest hurricane winds, coconut production for copra was not economically viable. Residents in this community had also had a difficult time identifying species that would be productive and not be severely damaged by the frequent typhoons that strike the area.

Overall discussion and conclusions

This chapter concludes with some overall discussion and conclusions regarding how the results presented here related to the overall goals and objectives of the study: 1. To describe upland management systems, 2. To assess system sustainability, and 3. To identify factors that promote the development of more sustainable systems. With regard to the first goal of management system description, the decision making models presented in this chapter provided a useful complement to the detailed system descriptions presented in Chapter 4. The previous descriptions were designed to answer the question "What is there?" The decision models presented in this chapter provided the start of an answer to the related question of "Why is it there?" Although the land management decisions were only a part of overall household decision making and did not include other important enterprises such as livestock, harvest of forest products or off-farm labor, they still provided some insights into the factors that went into the household decision making process. Important factors included household needs and goals, the potential constraints imposed by physical properties like climate, land type and soils, the important potential role of infrastructure and markets and the constraints imposed by household size and composition on labor availability.

With regard to the second study objective of sustainability assessment, the decision models in this chapter did not add significant additional information to the analysis presented in Chapter 5. However, they provided further evidence of the importance of some of the underlying factors behind the sustainability ratings that were discussed at the end of Chapter 5 including the complex interactions between physical, socio-politico-economic and household variables.

As expected, the decision models were most useful as a way to address the third objective of the study, the identification of factors that seem to promote or retard the development of more sustainable upland management systems. Based on these decision models and other interview data that were part of this analysis, several factors seemed to be important in promoting the development of more sustainable upland management systems.

The first of these factors was information. In order to develop more sustainable systems, information must flow both from residents to outsiders regarding management activities that have and have not worked, and from outsiders to residents regarding other potential management options for upland areas.

The second factor that was likely to facilitate the development of sustainable systems was the provision of infrastructure. Provided that land tenure was secure, improvement of the infrastructure in these types of communities could facilitate the development of more sustainable systems based on perennial species.

The third factor that was likely to facilitate the development of more sustainable management options was the continued improvement of markets for upland products. This development may need to include the development of processing facilities for those products with highly seasonal production that, during the time of this study, resulted in extremely low prices at harvest time.

The fourth factor that appeared to promote the development of more sustainable systems was that systems must be designed to distribute labor throughout the year in order to avoid the strong seasonal labor shortages that were common in these upland communities.

The fifth positive factor was the development of mechanisms to facilitate upland residents' access to planting materials for promising species. Closely related to this was the need for timely and accurate management advice, particularly for species that were not commonly raised by local residents.

In general, the factors that have a negative impact on the development of more sustainable systems were simply the opposites of the factors discussed in the previous paragraph. Lack of information, tenure, infrastructure, markets, labor, planting materials and extension advice all had a deleterious effect on the development of more sustainable systems. Residents attitudes toward risk, and the lack of programs available for upland residents to reduce their risk exposure also had a negative effect on the development of more sustainable systems. Particularly in the case of fruit or timber trees where there was a multi-year lag time between planting and production, residents attitudes and exposure to risk can have a significant impact. For example, at the present time in all three study communities, virtually all resident households were unwilling to go into debt to invest in perennial species cultivation. Even those households who were more strongly involved with perennials have developed these systems over time – with the exception of one household in Imbarasan / Himamara that had outside income from a salary job in the area.

Summary

Taken as a group, the decision models presented in this chapter provided information on the decision making process that residents of the three communities were using for their annual crop management choices. In addition, the seven household decision cases provided some insights into the decision criteria of the small number of households who had incorporated more perennial species into their management systems. Overall, both the models and the case studies highlighted the important and interacting roles played by household needs and goals, the bio-physical environment (climate, soils), household resources (land available, labor available) and socio-politico-economic conditions (infrastructure, markets). They also illustrated that most residents followed a logical strategy for their land management decision making within the context of the knowledge and resource constraints that they faced.

Chapter 7
Summary and recommendations

In this final chapter of the dissertation, I present a summary of the analysis discussed in the in the previous 5 chapters. After the summary, I discuss some of the future trends that seem important in the three study sites. This chapter concludes with some recommendations based on the results and conclusions of this analysis. I discuss recommendations both for future research activities and for development activities.

Summary

The entire analysis presented in the dissertation has been structured around the goal of addressing the problem of how to improve the management systems and the overall household livelihood systems of upland residents in the Philippines. Upland areas are an important region of the country and of many countries in Southeast Asia because of the direct benefits they provide, including food production, timber, fuel wood, and building materials, as well as the indirect benefits including watershed protection and preservation of wilderness areas. However, upland residents are one of the poorest groups of rural residents in the Philippines.

In order to address the study problem, three specific objectives were formulated for this study. They were:

1. To describe the local land management and household livelihood systems.
2. To assess the sustainability of these livelihood systems.

3. To identify important factors related to the development and use of more sustainable systems.

Based on a review of the literature, the nine agroecosystem analysis properties were chosen as the criteria on which to rate system sustainability and meet study objective number two. These properties appeared to provide a way to capture and organize a large amount of varied information regarding these systems and express it in a logical and consistent manner.

In order to meet study objective number three, a decision tree model was chosen as the framework for models of decision making in these communities. This decision was based on the observed ability of decision trees to successfully represent management decision making in other agricultural situations (Gladwin, 1989) and on the researcher's previous experience with using the methodology as the basis for an expert system that modeled land manager decision making regarding adoption of tree-based technologies (Robotham, 1997).

In order to meet the three study objectives, data was collected in the three Philippine upland communities: Imbarasan / Himamara, Mapaya, San Jose, Occidental Mindoro; Halang, Bayugo, Jalajala, Rizal and Upper Magsaysay, Infanta, Quezon. The communities were chosen using a number of general criteria that were discussed in Chapter 3. The most important of these criteria were: upland location, residents were members of lowland ethnic groups, and communities had been settled for 20 years or more. I hypothesized that residents of these communities that had been settled for approximately 20 years would have developed management systems that were relatively sustainable. Settlers who had not developed sustainable systems had probably left the communities. The three specific study communities represented some of the variety present in the uplands including differences in climate, soils and accessability including access to markets. They also represented different jurisdictional regimes and settlement patterns. As was expected given these differences in the physical and socio-economic environments, the dominant management systems used in the three communities represented a range of typical upland management systems.

Several data collection procedures were used including: informal interviews with residents, personal observations conducted by the researcher, soil sampling of selected land types and uses, collection of secondary data such as maps, rainfall data, and census information, and a formal survey of all households in the area. The survey (Appendix 3) included questions about a wide variety of household livelihood system attributes including land holdings, annual and perennial species, animals, income and expenses, and use of credit.

Objective #1

Descriptions of the major land management strategies and household livelihood systems were presented in Chapter 4. These included community level descriptions and brief descriptions of 20 example households that served as the basis for the household level sustainability assessments necessary to meet study objective number two. More detailed household descriptions were provided in Appendix 2. Management systems differed between and within the three communities. In Imbarasan / Himamara, most residents had both lowland and upland parcels. Their land management system consisted of *palay bukid* cultivation on their lowland parcels in the rainy season followed by cultivation of annual crops in the dry season dependent on available moisture. Important dry season crops included garlic, maize and mung bean. Upland holdings were managed using a long-fallow (7-10 years) shifting cultivation system. Typical annual crops planted in upland areas included upland rice, maize and cassava. Perennial species were also common in upland area including fruit trees, *buri* (*Corypha ulan* Lam.), and multipurpose trees species (e.g. leucaena, melina). Other important household livelihood activities included off-farm labor and raising small livestock (pigs, chickens).

The typical management system in Halang was somewhat different than the system in Imbarasan / Himamara. In Halang, residents used a short-fallow (2-3 years) shifting cultivation system that emphasized the production of upland taro for sale. Other important annual crops in their system were maize, upland rice and peanut. Cattle raising and charcoal making were other important livelihood activities and off-farm employment was an important source of cash income. Fruit trees were not an important component of management systems in this community except for a very few households.

The typical land management and livelihood systems in Upper Magsaysay were very different from the other two sites. Residents in this community managed their land using a very long fallow (15-20 years) shifting cultivation system. However, since the area had very high rainfall (nearly 4000 mm annually) and extremely acid soils, agricultural production was low. Residents grew one crop of upland rice on newly cleared lands and then switched to a mixture of annual and biennial crops including cassava, pineapple, taro and ginger. Coconut had been a common source of income in the area; however, with the collapse of the copra market, it was no longer profitable. The most important source of income for a majority of residents was the harvest of forest products from unclaimed lands further into the mountains including timber for building materials and rattan.

Objective #2

The second objective of the study was to rate the sustainability of various land management systems. The nine agroecosystem analysis properties were chosen as the rating criteria and three methods were used to combine these nine properties into one overall sustainability index: an additive method, a "law of the minimum" method, and a dominant value method. Systems were assessed at both the community and household level. Detailed calculations of the ratings and descriptions of the procedures used were presented in Chapter 5. At the community level, Halang received the highest ratings (Table 5.12). It was rated moderate using the additive index, moderate-high using the dominant value index and low using the minimum values index. Imbarasan / Himamara was rated moderate using the additive and dominant value indices and low on the minimum value index. Upper Magsaysay had the lowest overall ratings. It rated medium on the additive index but low on both the other indices. Ratings were also computed for the 20 example household (8 in Imbarasan / Himamara, 8 in Halang and 4 in Upper Magsaysay). These ratings (Table 5.26) identified some of the variation within the three communities. However, each of the three indices was dominated by one value. Most households (15 of 20) rated moderate on the additive index. A slightly smaller majority (14 of 20) rated low on the law of the minimum index. The dominant value rating showed the most variation; however, a simple majority (11 of 20) household were rated moderate.

Although the rating procedure provided interesting information and a good assessment of community and household status, it seemed to under-represent the diversity present within and among the communities and livelihood systems. There appear to have been several reasons for this including: the loss of detail during the aggregation process especially at the community level; and the fact that most households in these communities rate low or moderate compared to national averages in spite of easily visible differences between them. However, assessment of the various properties provided additional clues toward the identification of what appeared to be the most important underlying factors influencing overall sustainability. These were: the physical environment (climate, soils, topography) and the socio-politico-economic environment (access, markets, information, political power). The inter-relationships between these factors appeared to be of particular importance; specifically the dynamic relationship between productivity and accessability and the three-way relationship between productivity, markets and stability.

Objective #3

The third study objective was to identify some of the important factors that influenced the development of more sustainable management systems. The primary results used to address this objective were the decision tree models presented in Chapter 6. The development of these models helped to identify a number of important factors that influence resident decision making. These included: household goals and objectives, family structure and labor availability, and various constraints to the use of management strategies including lack of knowledge and lack of planting materials.

Examination of the small group of households who were using systems with a strong perennial crop component facilitated the identification of some of the factors that were of particular importance related to perennial species. These included: land availability, whether sufficient land was available to remove part of it from annual crop production; the availability of infrastructure and markets; and household attributes including labor availability, the desire to leave something for one's children, and the availability of outside income in order to provide household support in the time between planting and tree maturity.

Future trends

Since the concept of sustainability is directly concerned with systems persisting into the future, it is instructive to examine some of the future trends in the three study communities.

Imbarasan / Himamara

In Imbarasan / Himamara, no major changes appear on the horizon either from within the community or in the socio-economic context of the community. Agriculturally, continued expansion of garlic cultivation appears likely. Other within system changes seem less likely. This study showed some evidence of a shift by a few residents to management systems based on perennial crops; however, it was too early to tell if this represents the beginning of a community-wide trend or just the actions of a small group.

Major changes in the larger environment also appeared unlikely. Given the continued marginal status of Occidental Mindoro province as a whole, it seemed unlikely that the community would obtain the government support necessary to improve the road. One potentially positive development was a likely improvement in the peace-and-order situation in the community with the continued decline of the New People's Army insurgency nation wide. However, the impact of this change in peace-and-order may be relatively small. Migration to rural areas had slowed throughout the Philippines and most migrants to Occidental Mindoro were moving to flatter areas further north in the province where the government has started to develop irrigation systems.

Halang

As in Imbarasan / Himamara, within community changes in Halang were likely to be small. Their agricultural management system appeared to be reasonably stable at least in the near future and markets for major products (taro, cattle) showed no signs of slowing down. Since the area lacked land for expansion of holdings and was near to Manila, it seemed likely that the trend of young people leaving the area for jobs in the city would continue. Assuming that the land reform program continued to progress, all residents should obtain title to their land. However, this seemed unlikely to have a significant impact on management strategies. Given the continued marginality of the community, the development of a local water well and associated wind-powered pump seemed likely to be regularly referred to as a good idea, but never completed.

Changes in the external environment of the community were likely to continue; however, their potential impact on Halang was less clear. The potential for developing the area as high-value residential property remained and, in spite of the severe slow down in the Philippine real estate market caused by the 1998 Asian currency crisis, seemed to be the most likely long term scenario. However, development of this area for housing was unlikely to occur within the next ten years.

Upper Magsaysay

The future in Upper Magsaysay seemed to hold more options than the situations in Halang and Imbarasan / Himamara. Within the community, continued expansion of the population seemed likely. The population of the Infanta area continued to grow and ample land was still available in Upper Magsaysay. However, significant changes in local management systems seemed unlikely. The copra market showed no signs of returning to a viable level and there were no other species on the horizon with the hurricane and acid soil tolerance to replace coconut as an alternative perennial species. With the increasing population of Infanta town and the completion of a paved road from Infanta to Manila, residents may be able to take advantage of better markets for their crops (e.g. pineapple, cassava, ginger) and potential for non-timber forest products (e.g. rattan, resins, medicinals). However, access to the area from Infanta was likely to remain a problem. Harvest of residual timber seemed likely to become more difficult as residents would be forced to go further into the mountains to cut trees.

Recommendations

This study was conducted with a focus on two broad goals. First of all, the study used established theoretical principles, primarily agroecosystem analysis and the decision making theory of elimination by aspects, to assess the sustainability of upland management systems and to model management decision making. However, the study was also conducted as a search both for existing upland management systems and for guidelines for the development of upland management systems that improve the livelihoods of upland residents without compromising the environment, either in the upland areas themselves or in downstream areas. Because the recommended actions based on these two goals are somewhat different, I have divided the recommendations section into two subsections. In the first subsection, I present and discuss a set of recommendations for future academic research that builds on the results of this analysis and targets some of the questions left unanswered in this analysis. In the second subsection, I present and discuss a set of recommendations for management of these and similar upland areas as well as recommendations for upland development policies, programs and projects.

Further research

Both general and specific recommendations for future research were generated from this analysis. In order to increase clarity, this section is divided into two subsections: overall considerations and specific research activities. However, it is important to note that this distinction is artificial, specific research activities need to occur within the context of the overall considerations.

Overall considerations

At the general level, the results of this study suggested that future research in similar areas would benefit from a strategy that allowed data collection over the long term. This was particularly important for the assessment of the time-dependent components of the agroecosystem analysis (stability, maintenance, resilience, adaptability) where even one or two years of data was likely to be insufficient. A reliable assessment of a property like stability would benefit from upwards of ten or twenty years of data. However, given the present funding constraints facing most researchers and research institutions, the prospect of such long-term studies seemed slight. This analysis provided some guidance in this regard also. The analysis results suggested that, if the goal of the study was to identify the major factors influencing management systems, a data collection strategy using a rapid rural appraisal (RRA) approach consisting of a few, short, intense visits, may be sufficient.

However, the combined methodologies used in this analysis also illustrated some of the limitations of the RRA approaches. First of all, an RRA approach may miss important information. For example, information collected during short visits to Upper Magsaysay did not detect the importance of ginger as a cash annual crop. On the subsequent formal survey, a significant percentage of residents reported that it was an important component of their management systems. A similar case occurred in Halang where an earlier RRA classified area soils as generally acidic. Longer term involvement through this research and another project determined that acid soils made up only a small portion of area soils. Secondly, while rapid approaches seemed to have successfully identified the major factors operating in a community, it was difficult to detect the full range of management activities during a few short visits. The lack of variability in Upper Magsaysay as compared to Halang or Imbarasan /

Himamara seemed to be at least partially a result of the limited amount of time that I spent in Upper Magsaysay.

Specific research activities

The second group of recommendations for further research concentrate on specific research activities that build upon this research in order to expand the knowledge base. This group of recommendations is further divided into four categories: sustainability assessment, improvement of existing management strategies, identification of new alternative systems and household decision making.

Sustainability assessment

One logical extension of this research that could not be included in this study is the development of different potential weighting schemes and the assessment of their impact on the overall sustainability ratings. Another related idea is to design a study to try to identify a smaller set of system properties that will result in the loss of the smallest amount of information contained in the nine agroecosystem variables used in this study. A third idea is to apply an alternative sustainability assessment approach that concentrates on the assessment of relative sustainability levels of individual household management systems within a community (e.g. Gomez et al. 1996) instead of the approach used in this study of assessing system sustainability based on standards derived from regional and national information.

Improvement of existing management strategies

Another potentially valuable area for additional research involves working with farmers to further refine and improve their current management systems. One possible avenue of investigation involves the use of simulation models (such as DSSAT 3.1) to test various alternative management scenarios in one or more of the three study sites. As a first step, model parameters could be adjusted so that the model can replicate current conditions. Subsequently, the model could be used to estimate the likely impact of changes in management system components such as planting date, plant density and fertilizer application. New management strategies based on these model predictions could be tested in the area in cooperation with farmers in an ongoing process of system development.

Identification of alternative systems

Another related area of research is investigating other potential management options for upland areas with a given set of climate conditions. For example, local farmers indicated that mango and cashew were the only two fruit tree species that grew well in the two communities with a strong dry season (Halang and Imbarasan / Himamara). There is ample opportunity for the identification of other promising species and the development of appropriate management strategies that would serve to increase management options in these areas. Similar opportunities exist for vegetable crops. The identification of species, varieties, and management systems that are successful on the highly acid soils found in Upper Magsaysay is another area of potential research.

Household decision making

A fourth area of research that could potentially build on the results of this study is research into household decision making. Due to data limitations, I was only able to develop general models of land management decisions. However, household livelihood strategies involve more than just land management. Additional research specifically focused on both intra-household and inter-household decision making has the potential to provide an even greater understanding of how management systems have been developed and the constraints that need to be alleviated or opportunities provided in order for residents to improve their management systems.

Development activities

The second general class of recommendations that came from the results of this dissertation were those related to development activities: policies, programs and projects that were more likely to help improve the land management systems and overall household livelihoods of upland residents. As in the previous section, this section is divided into two parts. The first part discusses some general guidelines for development activities while the second proposes some specific activities for each of the study communities.

General guidelines

Many of the general guidelines for development activities mentioned in this section are not new. The results of this research and the author's experience in conducting the research have provided further evidence for the use of these guidelines. The first important guideline for development activities in upland systems is the need for participation by local residents — in Ruddle and Grandstaff's (1978) terms: transformational development instead of transferrential development. This has been shown to be a good general guideline in most situations but is of particular relevance in the uplands where the highly variable environment makes blanket recommendations even less likely to succeed.

Closely related to this idea is the need for successful development efforts to build on successful local practices. This study has shown that there were a wide variety of management systems being used in these three communities. Since these communities did not appear to be significantly different from most upland communities, it seemed likely that a wide variety of systems exist in most situations. As shown in this analysis, although most systems are of low or moderate sustainability based on national-level criteria, some individual household management systems were significantly more sustainable than others. Although the specific circumstances faced by any individual household are unique, more sustainable systems within a local community are far more likely to be relevant to other community residents than systems that come completely from the outside.

A third general guideline for development efforts in upland communities is the need for a long term commitment. Management systems are likely to change slowly, particularly when the change involves a switch to a perennial crop that may take several years to reach bearing age. The importance of ongoing activities can be illustrated by an example from this study. Cashew has been promoted in Imbarasan / Himamara as a potentially productive tree crop. I was involved in the initial distribution of seedlings while serving as a Peace Corps volunteer in the area from 1988-1990. These trees have now reached bearing age. However, several trees showed evidence of significant pest damage and corresponding severe reductions in yields. Residents did not have the knowledge of appropriate pest control practices for cashew and the original tree distribution project did not include a management component. This has left several residents with mature, but unproductive, trees.

However, the danger of over-planning is also real. In a highly varied environment like the Philippine uplands, it is tempting to try to plan for every contingency and, as a consequence, never get anywhere. This study provided ample evidence of the ability of upland residents to take information and management system alternatives, adapt them to their own needs and goals, and include them in their overall livelihood system if they fulfill a household need. The rapid adoption and nearly community wide use of taro cultivation in Halang was an example of the spread of a system that met resident's needs. The continuing spread of garlic cultivation in Imbarasan / Himamara provided another example.

A further guideline for upland development efforts that was supported by the results of this analysis was the need for an interdisciplinary approach to problems. In many cases, the solutions to agricultural problems may lie outside the traditional boundaries of the agricultural sciences. For example, pineapple and cassava both grow well in Upper Magsaysay, have significant potential for improvement, and could conceivably form the basis for a productive land management system. However, the lack of infrastructure in Upper Magsaysay and the small available market in Infanta town made the present monetary returns from both pineapple and cassava cultivation very low (low prices and high transportation costs). The development of increasing amounts of mango cultivation in Imbarasan / Himamara faced similar problems.

The last general guideline for upland development activities is particularly important in these days of decreased aid funding by the countries of the North and ongoing cuts in many government services in countries of the South like the Philippines. Any successful upland development effort in the current climate must have both public and private components. The potential of markets to drive system change was vividly illustrated in this study by the case of taro in Halang. However, residents of both Upper Magsaysay and Imbarasan / Himamara cited market and infrastructure constraints as a significant component of their decisions not to adopt systems based on cash crops or perennials.

However, these upland areas at present had little to sell and there was little incentive for private development of infrastructure. In addition, the adoption of new management systems may require additional skills. The private sector, at least in the Philippines, has shown little inclination to become involved in rural education. These are two areas where government involvement is essential to provide the underpinnings for the development of new systems.

Specific activities

I will conclude this dissertation with a list of a few specific development activities that are likely to help improve the situation in each of the study communities.

Imbarasan / Himamara

The primary problem cited by residents of Imbarasan / Himamara was the lack of a road that would extend from the existing highway into the area. This road would allow residents to transport agricultural products to market more quickly and at a lower cost. Residents indicated that road development was a prerequisite for the widespread adoption of systems based on the cultivation of perennials since these produce products that must be transported out of the area and sold. Therefore, the first recommendation for development activities in the area is for the construction of a road.

A second area of opportunity for development is related to tree cultivation. There are two important components that would be very helpful. First of all, as mentioned earlier, residents need more information on the cultivation of mango and cashew, the two common perennial species in the area at present. This information is particularly important in the area of pest and disease management. Secondly, other productive species that would help residents to diversify away from mango and cashew need to be identified.

A third potential area of development concerns annual crop cultivation. Area residents were using increasing amounts of pesticides on their paddy rice. A program designed to train residents in integrated pest management could have strong, positive environmental and economic impact.

Halang

Halang residents in general had more highly productive systems than residents of the other two communities. However, the basic management system in Halang was based on a very small number of species (taro, rice, maize, peanut). The identification of new species that are adapted to the area (both annuals and perennials) that residents could use to diversify their management systems is likely to have a positive impact.

Another issue in Halang was soil erosion. Although the highly weatherable parent material that underlies the area made erosion less of a local problem, the severe erosion from the area significantly decreased the productivity of individual fields and was likely to have negative impacts in areas downhill from the community. At present, many residents use an indigenous erosion control technique that involves strips of napier grass and banana laid out roughly across the slope. Development efforts that could build on and refine this technology (perhaps employing an A-frame to insure that the hedgerows follow the contour) have significant potential to reduce the off-field impacts of soil erosion. They also might help to increase field productivity. A third potential area for development in Halang, given the importance of cattle as a component of the management system, is improvement of the cattle stock and of cattle management. Although residents reported long experience with cattle, they did not have access to veterinary care. A program that would build on resident's knowledge of animal health and couple that with some basic principles of veterinary medicine could improve cattle health and productivity. Similarly, a program that would build on residents management knowledge and incorporate outside components such as improved feed ratios could also improve local cattle productivity.

Upper Magsaysay

Of the three study communities, Upper Magsaysay had the most problems and solutions to address these problems seemed to be the most difficult to find. However, I suggest three potential projects that address some of the major issues in the area. The first potential project is the development of a systematic program of forest maintenance and regeneration. Given that local residents were dependent on forest product for much of their livelihood and that the soils and climate of the area were relatively less well suited to annual crop production, the maintenance and possible restoration of forest lands seems to be a potentially useful strategy. However, several issues need to be resolved before any program of this time has a chance of success.

The first issue is tenure. As long as residents do not have clear rights to use their land, they are likely to remain reluctant to invest in perennials. This is particularly true of any project based on timber species. A second issue is use rights. In order for any program to promote forest regeneration and sustainable management to succeed, residents must be assured that they will continue to receive current and future benefits. The third issue is the need for increased information on the propagation of many valuable tropical hardwood species.

A second potential option to increase household productivity and sustainability in Upper Magsaysay is the introduction of livestock. Most households were not involved in livestock production beyond raising a few chickens for home consumption. However, there appears to be considerable opportunity for livestock in the area, especially cattle and goats, since an ample supply of fodder is available. But, a successful livestock program must include training for residents on animal husbandry and still may be hampered by access difficulties and the lack of a large market.

A third development option for Upper Magsaysay involves making some small improvements in the existing management system. For example, international research efforts have identified and developed upland rice varieties that grow productively on acid soils. A program or project that works with residents to compare these varieties to current varieties could be very useful. Similarly, more highly productive varieties of cassava and pineapple are also available and could be tested with residents and potential incorporated into local management systems.

Appendix 1
Species lists

Table A1.1. Names and citation frequencies of annual and biennial species identified by study community residents

English name	Local name	Scientific name*	I/H**	Hal**	UM**
Cereal grains					
Maize (corn)	Mais	*Zea mays*	vo	s	n
Lowland rice (flooded)	Palay bukid	*Oryza sativa*	vo	vo	s
Upland rice	Palay kaingin	*Oryza sativa*	s	vo	o
Roots					
Cassava	Kamoteng kahoy	*Manihot esculenta*	o	r	o
Onion	Sibuyas	*Allium cepa*	r	n	n
Purple yam	Ubi	*Dioscorea alata*	r	r	n
Sweet potato	Kamoteng baging	*Ipomoea batatas*	r	n	s
Taro	Gabi	*Colocasia esculenta*	r	vo	s
Yautia	Gabing San Fernando	*Xanthosoma sagittifolium*	n	n	r
Legumes					
Mung bean	Mungo	*Vigna radiata*	o	n	n
Peanut	Mani	*Arachis hypogaea*	r	vo	n
Pigeon pea	Kadyos	*Cajanus cajan*	r	n	n
Yard-long bean	Sitao	*Vigna unguiculata subsp. sesquipedalis*	s	n	r

Table A1.1. (Continued) Names and citation frequencies of annual and biennial species identified by study community residents

English name	Local name	Scientific name	I/H	Hal	UM
Vegetables					
Bitter melon	Ampalaya	Momordica charantia	r	n	n
Eggplant	Talong	Solanum melongena	r	n	n
Garlic	Bawang	Allium sativum	s	n	n
Ginger	Luya	Zingiber officinale	n	n	o
Kuchoba pumpkin	Kalabasa	Curcurbita pipo	r	n	r
Mustard (greens)	Mustasa	Brassica juncea	n	n	r
Okra	Okra	Abelmoschus esculentus	r	n	r
Tabasco pepper	Siling maanghang	Capsicum frutescens	r	n	r
Tomato	Kamatis	Lycopersicon esculentum	r	n	r
Watermelon	Pakwan	Citrullus lanatus	r	n	n
White calabash gourd	Upo	Lagenaria siceraria	n	n	n
Miscellaneous					
Pineapple	Pinya	Ananas comosus	r	n	o
Tobacco	Tabako	Nicotiana tabacum	n	r	n
Sugar cane	Tubo	Saccharum officinarum	r	n	r

*Scientific names from TC, 1986 and Wester 1924.
**Citation frequencies for each site are based on survey results: vo, very often, 60% or more of respondents; o, often, 30%-50%; s, seldom, 10%-29%; r, rarely, less than 10%; n, none, not cited by any respondent.

Table A1.2. Names and citation frequency of livestock species identified by study community residents

English Name	Local Name	I/H*	Hal*	UM*
Water buffalo	Kalabaw	vo	vo	o
Cow	Baka	s	vo	r
Horse	Kabayo	n	s	r
Pig	Baboy	o	r	o
Goat	Kambing	s	o	n
Chicken	Manok	vo	vo	vo
Goose	Ganza	r	n	n
Duck	Pato, Itik	r	n	r
Turkey	Pabo	r	n	n
Dove	Kalapati	r	n	r

*Citation frequencies for each site are based on survey results: vo, very often, 60% or more of respondents; o, often, 30%-50%; s, seldom, 10%-29%; r, rarely, less than 10%; n, none, not cited by any respondent.

Table A1.3. Names and citation frequencies of perennial species identified by study community residents

English name	Local name	Scientific name	I/H	Hal	UM
Fruit trees					
Avocado	Abokado	*Persia americana* Mill	r	s	o
Banana	Saging	*Musa spp*. usually *Musa acuminata* Cholla and *Musa balbisiana* Cholla	o	o	vo
Camachile	Kamatsili	*Pithecellobium dolce* (Roxb.) Benth.	r	o	r
Camansi	Kamansi	*Artocarpus camansi* Lam.	n	r	s
Duhat	Duhat	*Syzygium cumini* (Linn.) Skeels.	n	r	r
Guava	Bayabas	*Psidium guajava* Linn.	n	s	n
Jackfruit	Langka	*Artrocarpus heterphyllus* Lam.	s	o	vo
Katmon	Katmon	*Dillenia philippinensis* Rfe.	n	n	r
Lanzones	Lanzones	*Lansium domesticum* J.	n	n	r
Lipote	Lipote	*Eugenia curranii* C.B.R	n	n	r
Mango	Mangga	*Mangifera indica* Linn.	o	vo	o
Orange	Citrus, dalandan, cidra	*Citrus sinensis* (Linn.) Osbeck	n	n	vo
Papaya	Papaya	*Carica papaya* Linn.	r	r	n
Philippine lime	Kalamansi	*Citrus madurensis* Lour.	r	n	r
Pomelo	Suha	*Citrus grandis* (Linn.) Osbeck	n	n	r
Rambutan	Rambutan	*Nephelium lappaceum*	n	n	r
Santol	Santol	*Sandoricum koetjape* (Burm. f.) Merr.	s	s	s
Sapodilla	Chico	*Manilkara zapota* (Linn.) Van Royen	n	n	r
Sweetsop	Atis	*Annona squamosa*	r	s	n

Table A1.3. (Continued) Names and citation frequencies of perennial species identified by study community residents

English name	Local name	Scientific name	I/H	Hal	UM
Star apple	Kaimito	*Chrysophyllum cainito* Linn.	r	s	n
Star fruit	Balimbing	*Averrhoa carambola* Linn.	r	n	n
Star fruit	Kamias	*Averrhoa bilimbi* Linn.	n	n	r
Soursop	Guyabano	*Annona muricata* Linn.	r	s	r
Tamarind	Sampalok	*Tamarindus indica* Linn.	r	o	n
Tiessa	Tiessa	*Pouteria campechiana*	n	n	r
Multi-purpose trees					
Acacia	Aroma	*Acacia farnesiana*	n	vo	n
Gliricidia	Kakawate	*Gliricidia sepium* H.B. & K.	o	vo	n
Koa haole, leuceana	Ipil-ipil	*Leuceana leucocephala* (Lam.) de Wit	o	vo	n
Forest trees (timber trees)					
Melina	Gmelina	*Gmelina arborea* Roxb.	r	r	s
Monkeypod	Acacia	*Albizzia saman*	r	r	r
Philippine mahogany	Narra	*Pterocarpus indicus* Willd.	r	n	r
Almaciga	Almaciga	*Agathis philippinensis* Warb.	n	n	r
Lauan	Lauan	*Dipterocarpus spp.*	n	n	s
Mahogany	Mahogany	*Swietenia macrophylla* King	n	n	r
Eucalyptus	Eucalyptus	*Eucalyptus spp.*	n	n	r
Toon	Kalantas	*Toona calantas* Merr.	r	n	n
Borneo teak	Ipil	*Intsia bijuga* (Colebr.) O. Ktze	r	n	n
Molave	Mulawin	*Vitex parviflora* A. Juss.	n	r	n

Table A1.3. (Continued) Names and citation frequencies of perennial species identified by study community residents

English name	Local name	Scientific name	I/H	Hal	UM
Commodity trees					
Cacao	Kakaw	*Theobroma cacao* Linn.	n	n	r
Cashew	Kasoy	*Anacardium occientale* Linn.	o	r	n
Coconut	Niyog	*Cocos nucifera* Linn.	r	r	vo
Coffee	Kape	*Coffea spp.*	n	r	s
Grasses, bamboos, palms					
Imperata grass	Cogon	*Imperata cylindrica*	o	n	r
Tiger grass, broom grass	Lasa	*Thysanolacaena maxima*	n	n	r
Spiny bamboo	Kawayan tinik	*Bambusa blumeana* Schult.	vo	o	s
Bamboo	Patong	*Gigantochloa levis* Blanco. Merr.	s	n	n
Bamboo	Bayog	*Bambusa bulmeana var luzonensis* Hack	n	r	n
Rattan	Uway, rattan	*Calamus spp.*	n	n	s
Limuran (rattan)	Limuran	*Calamus ornatus* Blume ex Shut	n	n	r
Buri palm	Buli	*Corypha ulan* Lam.	vo	n	r
Anahaw	Anahau	*Livistona rotundifolia* (Lam.) Mart.	n	n	r

*Scientific names from Brown 1946, 1951 and 1954; Tomboc 1991a and 1991b; BPC, 1991; Hensleigh and Holaway 1988; and Webster 1924.

**Citation frequencies for each site are based on survey results: vo, very often, 60% or more of respondents; o, often, 30%-50%; s, seldom, 10%-29%; r, rarely, less than 10%; n, none, not cited by any respondent.

Appendix 2
Detailed descriptions of example household livelihood systems

This appendix contains detailed descriptions of the household livelihood systems of the twenty example households used in the study analysis. Brief descriptions of the household livelihood systems were provided in Chapter 4. All of the descriptions follow the same format beginning with a summary of the land resources available to the household, this is followed by description of family attributes, settlement and management history, the current livelihood system and an estimated household budget.

Households in Imbarasan / Himamara

Household IH1

Land

The household controled a total of 5 hectares of land. Four of these hectares were located in a lowland valley adjacent to one of the major perennial streams in Himamara. The one hectare of upland was adjacent to the lowland and included the family house. Three of the four lowland hectares were irrigable at varying levels during dry season. The family also owned part of a house and lot in San Jose that they shared with the husband's brother.

Family attributes

The household consisted of a nuclear family. The parents were both in their 50's. They had 7 children. Two of their children, in their twenties, were married and had settled in the area. One son was working in Manila. The other four children were attending high school in San Jose. They lived in the family house and attended school during the week and return home on weekends.

Settlement and management history

The husband was one of several brothers who were part of one of the first families in the area. Their parents were the first to settle in Himamara. They came from Aklan Province on the island of Panay in 1942, moved to lower Mapaya in 1952 and settled and cleared their present location in 1956. The wife was the daughter of one of the first settlers in the lower portions of Imbarasan. Along with his father and brothers, the husband's family settled and claimed a large amount of unoccupied valley land in Himamara on both sides of one of the larger perennial streams. He inherited use rights to the land when he got married and had taken over complete management control since his parents were in their 80's. The family had been awarded a lease (CSC) from the DENR.

They moved into Himamara soon after the land had been logged of the large, economically valuable trees. They cleared the land of the remaining residual forest and initially used a slash and burn cultivation system. This developed into plowed field agricultural system, and, over time they leveled and bunded their land to create permanent *bukid* that were flooded for rice cultivation in rainy season.

Current livelihood system

Their livelihood system was based on the cultivation of annual crops on their lowland parcel, cultivation of a few vegetables on higher terraces and raising some small livestock.

Annual crops

The major annual crops cultivated, area cultivated and approximate yields are shown in Table A2.1. Lowland rice (*palay bukid*) was the most important species in their management system and they cited mung bean as the second most important. Rice was grown for home consumption and also sold. Mung bean was grown for sale but some was retained for home consumption. Their primary cash crop was garlic. They considered 1996 to be a poor year with a yield of 500 kg from 50 kg planting material. In the previous year, they sold 875 kg of garlic for total returns of P70,000 in addition to the amount they retained for home consumption and used as planting material.

Table A2.1. Annual crops for example household IH1

Crop	Area (ha)	Total yield (kg)	Yield (kg/ha)	Peso equivalent**
Palay bukid (main crop)	4	12000*	3000	96,000
Palay bukid (2nd crop)	2	6000*	3000	48,000
Garlic	0.5	550	1100	44,000
Mung bean	1	350*	350	7,000

*Based on average reported yields from household in the group
** Based on selling all of the crop at the following prices: rice, P8/kg, mung bean P20/kg, garlic P80/kg.

They have observed that their rice yields have declined over time. This past cropping season, they applied 3 sacks of complete (14-14-14) fertilizer and 3 sacks of urea (48-0-0) on each hectare of their rice. This resulted in a total nutrient application of 93 kg/ha nitrogen, 9 kg/ha phosphorus and 17.5 kg/ha potassium. They also applied both fertilizers and pesticides to their garlic. Even though they received significant cash income from garlic cultivation, they still borrowed money for rice inputs using the standard repayment system of 5 sacks of unmilled rice in payment for each P1000 in loan. Part of the reason for this was that they were located far from the road. If they borrowed money from a rice mill, the miller agreed to purchase their crop and to send a truck to collect it and bring it to San Jose.

Livestock

In addition to annual crops, the household also raised some livestock. They owned two buffalo that were used as a draft animal for plowing, harrowing and hauling. They also owned two pigs that they were raising for sale and ten chickens that they planned to use for home consumption. They had dogs and a cat that served as watch dogs and for rodent control.

Perennials

This household did not put much effort into the cultivation of perennials. They asserted that the strong dry season in Himamara made it extremely difficult to establish fruit tree species and so they choose to concentrate on annuals. They collected firewood and other natural products used for household tasks (primarily buri and bamboos) from common areas along the stream and further up into the mountains.

Other activities

The household did not engage in any other activities. The management of their lowland holdings effectively occupied most of their time and agricultural products provided all their necessary cash income. Because they had irrigable land, they were busy throughout the year.

Estimated household budget

Based on the income and expense sources provided by the household, amounts from other households surveyed and general knowledge of the area, I developed the estimated household budget is shown in Table A2.2. As was apparent from the table garlic was the most important source of cash income for the household. In spite of lower yields this year than in the past, they were still able to purchase a new hand tractor trailer. In past years, they have used the money from garlic cultivation to purchase a hand tractor for use in their paddy fields, a new diesel water pump for dry season irrigation, and have put a metal roof and cement floor on their house. As has been the case for the past several years, school expenses took a major portion of household resources.

Table A2.2. Estimated household budget for example household IH1

Income	Amount	Expense	Amount
Rice	52,500	School	36,000
Garlic	36,000	Food	18,000
		Household	12,000
		Farm equipment	15,000
Total income	88,500	Total expenses	81,000
Net income	7,500		

Notes: Rice income is net after expenses and 60 sacks saved for home consumption and seed. Garlic income as net income. School expenses at P1000/month/child for 9 school months/year.

Household IH2

Land

The household land holdings were located on the southwestern boarder of Imbarasan. The family had three parcels of land: an approximately 0.6 ha parcel of valley land suitable for paddy rice cultivation, rights to 1.5 ha of an approximately 3 ha parcel of upland hillside and hilltop located on one of the sandy hills in lower Imbarasan about I km from the lowland field, and a small house lot located in Mapaya proper near the chapel and not far from the main elementary school and about 3 km from their lowland plot. The family held clear title to the house lot. Title to the valley parcel was held by the head-of-household's father; however the husband received the right to use it as he saw fit when he got married. The 3 ha hillside parcel was foreclosed on by the Land Bank. The head of the household and his father acquired shared use-rights to the parcel in the form of a mortgage (for P9000).

However, payment was not required until the land had been made productive. During dry season, the household also managed an adjacent small parcel of lowland (approximately 0.6 ha) that belonged to the husband's brother who resided in San Jose town.

Family attributes

The household consisted of a husband and wife, both about 30 years of age, and their four small children ranging in age from 9 to 2. The oldest two children helped with basic household tasks; however, they were not old enough to be of significant help with agricultural activities. The two oldest children attended the local public elementary school and the third child will start school in 1997-98.

Settlement history

The husband was born and raised in *barangay* Mapaya on a farm that bordered on *sitio* Imbarasan. His father was one of the earliest settlers in the area (1951) and he was related to a number of other area residents. The wife was born and raised elsewhere and moved to the area when she got married. The husband grew up in the area and returned to the area when he got married. He inherited a 0.6 ha parcel of well-developed valley rice land from his father and continued to manage that land for rice in a similar manner to how his father had done for many years. The addition of garlic into the system as a dry season crop was the only major change in his management strategy in recent years. They had cultivated garlic for at least 5 years. Before the children started school, they lived on their upland parcel and managed it more intensively by cultivating sweet potato and cassava in the areas between and around the young cashew trees. However, since they were no longer living there, the parcel was being used exclusively for perennials.

Current livelihood system

The current livelihood system for this household was based primarily on annual crops but also included some small livestock and some perennial species. The household was also dependent on off-farm labor to supply a significant portion of its cash needs.

Annual crops

The principal activity of the household was the cultivation of annual crops. Crop information for the 1995-1996 season is shown in Table A2.3. They grew one crop of *palay bukid* during the rainy season on their one hectare of valley land. In the dry season, a small section of this area was planted to maize, another to garlic and most of the remainder to mung bean. Their rice was used primarily for home consumption. Maize was used for animal feed. Some garlic and mung bean were used by the household and the rest was sold.

The household used significant inputs of both fertilizer and pesticides in rice and garlic cultivation. For rice, they applied 3 sacks of urea and 3 sacks of complete fertilizer per hectare. This provided a nutrient equivalent of 93 kg/ha N, 9 kg/ha P and 17.5 kg/ha K. On their 0.2 ha of garlic, they applied 2 sacks of complete and 1 sack of urea (190 kg/ha N, 30 kg/ha P and 60 kg/ha K). They used insecticide, fungicide and molluscicide on their rice and several different insecticides and fungicides on their garlic. In order to purchase these inputs, the household borrowed P6,000 per year from a local lender under the prevailing repayment system of 5 sacks of unmilled rice for each P1000 of loan.

Table A2.3. Annual crops for example household IH2

Crop	Area (ha)	Total yield (kg)	Yield (kg/ha)	Peso equivalent*
Palay bukid (main crop)	0.6	2400	4000	18,400
Palay bukid (2nd crop)	0.3	800	2700	6,400
Mung bean	0.25	400	1600	8,000
Maize	0.2	50	250	1,500
Garlic	0.2	300	1500	24,000

*Based on selling all of the crops at the following prices: rice, P8/kg, maize P6.50/kg, mung bean P20/kg, garlic P80/kg

Livestock

The household also managed a small number of animals. They had several chickens and one pig that they were fattening for sale. They were involved in caring for cattle under a local system where the cattle owner provided the cows to the care giver. In return for caring for the cows, the care giver received the 2nd, 4th, 6th etc. calf. However, only one calf was born during the year of this study and before the end of the year, the head-of-household decided that the labor involved with cattle raising was more then he could do and returned the cattle to their owner. The household also owned 2 buffalo, an adult female and a one year old male. The female was of working age, the male will not be able to be used for work until it is three years old.

Perennials

In addition to the annual crops and animals, the household managed some perennials. They planted approximately 100 cashew trees on their upland parcel in 1990. These trees had started to bear fruit; although the yield was very low in 1996. In addition, they had also planted some gmelina on their upland parcel for future use as building material. On their small house lot they planted a few banana plants; however these have not reached bearing age.

Even though they did not have a wide variety of perennials on their own holdings, they used a number of other perennial products. They reported harvesting 100 bundles of cogon grass for house roofing from common lands in the area. Wood for cooking fuel came from common lands near the small river that flowed near his father's holdings or from his father or brother's upland holdings. The household also harvested fruits and sometimes vegetables from the holdings of other family members. Bamboo used for household needs was harvested from common lands in Imbarasan.

Other activities

Both the husband and wife worked off-farm during the times of peak demand for agricultural labor. The husband tried to work off-farm whenever it did not conflict with necessary management activities on his own holdings. In fact, he was more likely to postpone his activities temporarily to take paid employment.

Estimated household budget

Based on the income and expense sources and amounts provided by the household and general knowledge of the area, I developed the approximate household budget is shown in Table A2.4. Extremely good crops of mung bean and garlic helped the household to meet expenses during this year and made up for a relatively poor rice harvest. School expenses were low at present since the children were still at the local elementary school. These expenses were likely to rise considerably as the children get older necessitating additional income. The most likely potential sources of this income were expanded cultivation of garlic and additional off-farm labor.

Table A2.4. Estimated household budget for example household IH2

Income	Amount	Expense	Amount
Rice	15,000	Food	10,000
Mung bean	10,000	Ag expenses	10,000
Garlic	10,000	House and family	14,000
Off-farm work	7,500	School	2,500
Total income	42,500	Total expenses	36,500
Net income	6,000		

Notes: 100 days total off-farm work, other income and expenses as reported, school expenses based on 36 school weeks/year.

Household IH3

Land

Household IH3 had land holdings in *sitio* Imbarasan that included 0.5 hectares of rainfed lowland and 2 hectares of upland divided into four parcels. One parcel of upland (0.25 ha) was occupied by annual crops, another parcel (0.25 ha) by fruit trees, a third parcel (0.5 ha) by bananas and a fourth parcel (0.5 ha) by second growth forest.

Family attributes

The household consisted of a nuclear family with 8 children ranging in age from 1 to 18. The husband and wife were both approximately 40 years old. The oldest to children had finished school, the third child was in high school and two other children were in elementary school. The youngest three children had not yet reached school age.

Settlement and management history

The adults arrived in the community from Panay island in 1975 as a young, newly married couple. Their reason for migrating was "*humanap ng magandang kapalaran*", looking for good luck. They settled a vacant parcel of land and have since received a CSC to their holdings. Since they arrived after the first migrants had claimed the best portions of valley land in Imbarasan, their lowland holdings were in a particularly low area and they had difficulty with flooding during the rainy season. Additional information on the development of their management system was not available.

Current livelihood system

Their current livelihood system included the cultivation of both lowland and upland annuals, small livestock, cultivation of some perennial species and use of some forest products. Unlike many other families in the community, they did not report having to supplement their income through off-farm employment.

Annual crops

The types, amounts and yields of annual crops grown by the household are shown in Table A2.5. The rice yields based on the one-fourth hectare harvested were well within area averages; however, they seeded their entire one-half ha of lowland and were only able to harvest one-half of their available lowland due to flooding problems giving them a poor return from seed planted (10:1). Their low landscape position allowed them to take advantage of early season moisture provided by a rare March typhoon and they were able to grow an extra crop of maize between April and July. They planted the entire lowland area to mung bean in dry season. Cassava was planted on one of their upland parcels. Their rice, cassava and portions of their maize and mung bean were all used for home consumption. Some maize and mung bean were also sold. They only applied chemical inputs in rice cultivation and then only applied 1 sack (50kg) of urea (elemental equivalent 48 kg/ha of N) and a small amount of insecticide.

Livestock

In addition to annuals, the household had some livestock. They had a buffalo that they used for agricultural and other work as well as 5 chickens that were used for home consumption. They were also raising one pig that would be sold when it reached marketable weight.

Table A2.5. Annual crops for example household IH3

Crop	Area (ha)	Total yield (kg)	Yield (kg/ha)	Peso equivalent*
Palay bukid (main crop)	0.25	750	3000	6,000
Mung bean	0.5	150	300	3,000
Maize	0.5	250	500	1,625
Cassava	0.25	200	800	700

*Based on selling all of the crops at the following prices: rice, P8/kg, maize P6.50/kg, mung bean P20/kg, cassava 3.50/kg

Perennials

The household also made use of various perennials. Buri (*Corphya ulan* Lam.) was used for a variety of things, including ties for rice bundles at harvest. They also reported harvesting spiny bamboo and *ipil-ipil* (leucaena) from their upland holdings for household use and for firewood respectively. Although they did not mention cultivating large numbers of any specific fruit tree species, the household made use of a variety of fruit tree products for both home consumption and sale. Based on other households in the area, likely fruit trees present included jackfruit, banana, star apple and santol (*Sandoricum koetjape*).

Other activities

The livelihood system of this case study household was strongly based in agricultural activities. Unlike many households in the study communities, this household did not report engaging in off-farm labor or in any other, non-agricultural pursuits.

Estimated household budget

Based on the income and expense sources and amounts provided by the household and general knowledge of the area, I developed the approximate household budget is shown in Table A2.6. The data showed that household expenses were considerably higher than household income. The household reported having borrowed P15,000 from local lenders over the past year to meet agricultural, school and food expenses. Given the prevailing interest rates, this amount of debt cast a cloud over the future of the household, particularly if they have similar bad luck with next year's rice crop. They had several children already in school and three more that had not yet reached school age. Given the household resources, the most likely potential source of additional income was one or more of the parents and older children working off-farm for wages.

Table A2.6. Estimated household budget for example household IH3

Income	Amount	Expense	Amount
Maize	1,200	Food	36,000
Mung bean	2,000	Ag expenses	5,000
Livestock	5,000	House and family	5,000
		School	5,000
Total income	7,200	Total expenses	51,000
Net income	-43,800		

Notes: Expenses and income as reported plus assume sale of 100 kg mung bean and 200 kg maize.

Household IH4

Land

The specific example household had 2 ha of *bukid* at the head of one of the valleys in Imbarasan. The lowest 1 ha near the creek had a high water table in rainy season and were only suitable for paddy rice cultivation. These areas could be irrigated from the creek in dry season. The adjacent 0.5 hectares could be flooded in wet season or planted to upland crops. The remaining 0.5 hectares contained the house and lot and adjacent upland areas. They also owned 7 hectares of land in Sablayan (another municipality in Occidental Mindoro, about 100 km to the north of San Jose) that was now being used by two of their older, married, children and a small parcel in Magsaysay (the municipality to the east of San Jose) where another married child resided.

Family attributes

The household was made up of a husband and wife and two of their unmarried sons, both of whom were still attending school in San Jose. The couple was in their 50's and their older children had married and lived elsewhere. One unmarried son lived and worked in Manila. The wife had relatives in the area.

Settlement and management history

The couple arrived in Imbarasan in 1991 from Sablayan. They had lived in Magsaysay initially and then relocated to Sablayan. Peace and order problems forced them out of Sablayan and after being unable to obtain sufficient land near their previous holdings in Magsaysay, they ended up in Imbarasan because the wife had relatives in the area. They purchased their land from a former resident who had developed the paddies and upland fields. They took over the CSC of the previous owner as was common in the area, in spite of the fact that CSC's could not officially be sold. They had pursued their current management system since they arrived in the area.

Current livelihood system

The current livelihood system was focused on the cultivation of rice and vegetables. The household also managed some perennials, some small livestock and had done some low intensity fish culture in the past.

Annual crops

The household livelihood system was primarily based on annual crops. They planted two crops of paddy rice on 1 ha of land. Natural precipitation was used for rice cultivation in rainy season while the dry season crop was irrigated from a small pond and swampy area next to perennial stream that ran along the edge of their property. The rice was primarily grown for family consumption but was sold if surpluses were available. The other major component of the livelihood system was the cultivation of a variety of vegetable crops. The primary vegetables cultivated for sale were bitter melon, squash, yard-long bean, petchay (a leafy green vegetable), eggplant and okra. They also cultivated a small amount of garlic for home use and sale and a small amount of inter-cropped maize and cassava for chicken feed.

The rice was grown using the typical management strategy and input levels common to the area. Since household cash flow was not tied exclusively to rice cultivation, they used less than average inputs of fertilizer on his crops and used very low inputs on his minor crops of maize and cassava. For vegetables, they cropped one specific vegetable in a given plot for multiple crops until they noticed that yields were dropping, then they rotated plots. The only vegetable that they did not rotate was bitter melon since they had constructed a permanent terrace. He planted vegetables year-round. He furrow irrigated with water from his natural pond in early dry season and then hand irrigated (pail and dipper) during late dry season. As a consequence, he planted more vegetables in December-January than in February-March. He had noticed that the fertility of some of his vegetable fields had been dropping over time. He intended to construct bunds and flood these fields in the upcoming rainy season and to plant them to rice in hopes that this would help improve fertility.

He reported that vegetable cultivation was very input intensive; however I was unable to conduct follow-up interviews to record the exact levels of inputs used. He applied a wide variety of insecticides and fungicides to insure the quality of his vegetables and said that this was necessary to sell them at a good price. He also applied considerable amounts of fertilizer as evidenced by the very high phosphorus and potassium values shown in the soil tests from two of his vegetable fields (Table 4.1). In addition to chemical fertilizers, he applied chicken manure from his chicken house to his bitter melon. He said that it was important to apply manure to that area since it was covered with a permanent terrace and he did not rotate crops there.

Table A2.7 shows the estimated yields of rice and various other annual crops cultivated by the household. Harvest amounts and values were estimated using a combination of data provided by the household, my observations recorded during household visits, information on vegetable yields given by other area residents, and vegetable prices from the Philippine Department of Agriculture.

Table A2.7. Annual crops for example household IH4

Crop	Area	Yield	Yield/ha	Peso equivalent*
Palay bukid (main crop)	1 ha	3000 kg	3000 kg/ha	24,000
Palay bukid (2nd crop)	1 ha	3000 kg	3000 kg/ha	24,000
Maize / Cassava inter-crop	0.5 ha	150 kg maize 400 kg cassava	300 kg/ha 800 kg/ha	975 1400
Bitter melon	0.125 ha	1400 kg	11,200 kg/ha	224,000
Squash	0.125 ha	500 pieces	4000 pieces/ha	40,000
Yard-long bean	0.125 ha	500 bundles	4000 bundles/ha	8,000
Garlic	0.125 ha	200 kg	1500 kg/ha	16,000

*Assumptions: Entire crop sold, rice P8/kg, maize P6.50/kg, cassava P3.50 /kg, bitter melon P20/kg, squash P10/piece, beans P2/bundle, garlic P80/kg.

Livestock

The household had a limited amount of livestock. They had a buffalo that was used as animal traction for the tasks associated with *palay bukid* cultivation and for plowing and harrowing in vegetable fields. The only other livestock raised were chickens. They were the only household in the area to raise chickens in confinement. This allowed them to collect the manure for use in vegetable cultivation and also prevented the chickens from damaging vegetable crops. In addition to native chickens that they raised for eggs and meat, the husband had several fighting roosters.

Perennials

The household had a few perennials including two large mango trees. They sprayed the trees to induce flowering in 1996 but got no marketable yield. They had sold mangos in past years. They used other perennials, bamboo and small trees on their property for fuel wood and other household needs.

Other activities

The household had stocked the natural pond near their holdings with some tilapia fingerlings and hoped to obtain some fish for home consumption. However, they were not managing the pond for fish production and were relying exclusively on natural food sources. They also had retained some interest in both their parcel of land in Sablayan and their land holdings near the ocean in Magsaysay. However, they were not involved in the day-to-day management of either of these areas. Management activities associated with their holdings in Imbarasan occupied the bulk of their time.

Estimated household budget

Since the information on this household was based on limited data, any budget figures were very rough estimates. Although I was confident of the rough magnitude of gross returns from the various household enterprises, I lacked detailed information on household expenses, specifically those expenses related to vegetable cultivation. This was particularly important because they noted that vegetable cultivation requires significant inputs, particularly of insecticides, in order to produce marketable returns. In addition, this household relied on hired labor for many of their activities. Based on my original interviews with the household, the net returns from vegetable cultivation, although certainly significant, were much less than the gross returns noted in the previous section.

For the purposes of the estimated budget in Table A2.8, I estimated vegetable production expenses at one-half of the gross returns, rice expenses at the local average of P10,000/ha and garlic expenses at P4000 based on figures provided by a neighbor for a similar area of garlic. The types of other expenses were provided by the household; however the magnitudes were based on amounts from other, similar households. The husband required treatment for kidney stones during the year and went to Manila for the treatment. He stayed with his son in Manila during that time. The household also reported having a significant, but unspecified, amount of debt remaining from problems in the past. This was not included in the estimated budget.

This estimated budget still showed a very high net income. However, the household had not invested in any of the items that typically went with increased income in the area including improvements in their house (e.g. metal roof or cement floor) or the purchase of farm equipment. This led me to believe that one or a combination of three situations existed: 1. Past debts were a very significant drain on the household livelihood system. Given the very high interest rates common in the area, this was definitely a possibility. 2. Expenses associated with vegetable production were higher than I estimated and consequently the returns to vegetable cultivation were less than my estimates. 3. I developed over-optimistic estimates of vegetable production by assuming average or better yields and average prices for all vegetables. Since San Jose was a relatively small market, vegetable prices were likely to fluctuate significantly within fairly short time periods making the prediction of returns to vegetable sales more difficult.

Household IH5

Land

The household land holdings were located in Imbarasan, in the second set of hills. The household had access to about 3 hectares of land, all of it sloping on both sides of a small, seasonal stream. The farmer classified his soil as *puro buhangin* (all sand). Soil samples that I took from his fields were sandy loam in texture and showed the soils to be generally infertile.

Table A2.8. Estimated household budget for example household IH4

Income	Amount*	Expense	Amount
Rice	22,000	Food	24,000
Vegetables	136,000	Household	12,000
Garlic	12,000	School	18,000
		Medical treatment in Manila	20,000
Total income	170,000	Total expenses	74,000
Net	96,000		

*Net income after expenses, see explanation in text above

Family attributes

Household IH5 consisted of a young man and his wife who were both in their late 20's and their three young children. The husband was born on Iling Island (near San Jose) but grew up in the Imbarasan / Himamara area. His father had died but his mother and several siblings and half-siblings still resided in the community. His wife grew up in the area and several of her family members still resided in or near the community.

Settlement and management history

In 1989-90, the newly married couple got permission to take over and use the former "barrio site". In the original survey of the area for the community tree farm program (CTF -- the precursor to the ISFP) , this area had been reserved for use by the project to generate income. However, with the conversion of the area to an ISFP area in 1987, plans to make use of the area had stalled and the area remained in fallow. In return for agreeing to participate as a model farmer in a DENR demonstration planting program for mango and cashew trees, the household was allowed to use the land for annual crops. After the Peace Corps volunteer assigned to the area left in 1990 (that was me), the demonstration project was never pursued and the household retained control over the land. The had applied for a lease (CSC) but the papers had not yet been completely processed.

As part of the demonstration project, one hillside (approximately 1 ha) of the area was cleared and burned. Mango and cashew seedlings were planted on 5 meter spacing for the project and the household inter-cropped maize between the tree seedlings. Since that time, they had been trying to develop a productive system on their land holdings. They had gradually shifted over time toward and increasing focus on perennial species. This was in response to two factors: 1. the poor growth of maize on their land; particularly after the first couple of years and 2. observation of the mango plantations that exist on similar land nearby -- specifically the one run by the dela Roca family (one of the few absentee land owners in the area). They also tried bananas but had high mortality which he attributed to drought stress in dry season. So, they had not planted any new bananas in the last couple of years. They had been moving their small kaingin fields around their holdings since they settled the parcel and had yet to identify an area where annual crops grow well, even in the first year. However, they were still dependent on annual crop cultivation for basic subsistence.

Current livelihood system

The current livelihood system was a result of the adaptation and experimentation process discussed in the previous section. In 1996 they planted both upland rice and maize as annual crops. They also continued to cultivate an increasing number of perennials and care for a few small livestock. Forest product collection and off-farm employment were also important components of the household livelihood system.

Annual crops

On the newly cleared *kaingin*, approximately 1 ha in size, they planted maize. On the flatter portions of the area near the hilltop, they inter-planted the maize with a local *palay kaingin* variety, *Azucena*. The maize was dibble planted; however, they borrowed a buffalo in order to plow the approximately 1/4 ha planted to rice-maize inter-crop. They, and all upland residents interviewed, prefered to plant *palay kaingin* in plowed areas if possible since plowing helped to reduce the weed competition that was seen as the biggest problem in upland rice cultivation. The one hectare of maize yielded only 75 kg of grain, a very poor harvest, with a potential cash value of only P515. The rice yield was 100 kg from 0.25 ha or 400 kg/ha for a potential cash value of P4000 (assuming a price of P10 for the more flavorful upland rice). Both the crops were grown with very low external inputs, labor was provided by the household and no fertilizers and only a small amount of insecticide were used.

Livestock

The household only had a small number of livestock. They owned a few chickens for home consumption as eggs and occasionally as meat. They also owned two goats that can be sold if necessary to raise cash or may be used for food on special occasions such as a christening for one of the children. They did not own a buffalo and so must haul farm products by hand or hire or borrow a buffalo from relatives or other area residents. Since they had many relatives in the area, they were probably able to borrow a buffalo as necessary, perhaps in return for a small percentage of the sale proceeds of the item hauled. However, I did not specifically ask them to explain this situation.

Perennials

On an increasing amount of their land, over 1 ha, they had planted mango and cashew trees. The oldest of these trees were planted in 1990 as part of the original demonstration project and the cashews were bearing fruit. They harvested a small amount of cashew for personal use in 1995 but did not harvest in 1996. The mangoes had not flowered yet -- the oldest were planted in 1990 so they were expected to flower in 1997. This was not inconsistent with the 5-7 year expected maturity of mangoes. The household had continued to plant additional mango and cashew seedlings as they could obtain seedlings. They had gotten cashew seedlings free from the DENR and had purchased a small number of mango seedlings from the Department of Agriculture nursery. Unlike the larger mango producers in the area, the household had decided to focus on the Indian and Pico mango varieties instead of on the more popular Kalabaw variety. Although Indian and Pico mangos command a lower price in San Jose, they were usually eaten green. This mades them easier to harvest and to transport. Transporting Kalabaw mangos out of Imbarasan / Himamara for sale in the fresh market was extremely difficult since they bruise easily.

In addition to their fruit trees, they had harvested small amounts of buri and bamboo for both household use and sale and also harvested two large trees from common lands in order to construct their house. He also worked with his brothers to make charcoal for sale during the dry season.

Other activities

The household had very few dry season agricultural activities, due to unavailability of water, other than clearing and burning their *kaingin*. Since the wife was busy caring for their small children, the husband worked off-farm as often as possible during dry season to obtain cash income. He primarily worked as an agricultural laborer for neighboring farmers who had access to irrigation and therefore have dry season crops. He also worked occasional odd jobs as these were available.

Estimated household budget

As was apparent from Table A2.9, this household had the lowest cash flow of any of the case study households. All of their agricultural production was used for the household itself. As a consequence, their potential sources of income were a small amount from the sale of a goat, sale of charcoal and other forest products, and off-farm employment. Their expenses were also low. However, they were in a precarious situation. Unforeseen expenses from illness or other problems could have severe effects on the household. In addition, their expenses were guaranteed to increase in the future as their children reach school age.

Table A2.9. Estimated household budget for example household IH5

Income	Amount	Expense	Amount
Sale of goat	1,000	Food	12,000
Charcoal (100 sacks)	4,000	Other household	4,000
Off-farm employment	11,250		
Total income	16,250	Total income	16,000
Net income	250		

Assumptions: Goat sells for P1000, charcoal for P40/sack, 150 days off-farm employment

Household IH6

Land

The case study household (IH6) owned one contiguous parcel of land that was about 7 ha in size. Virtually all the land was sloping and ran from the hilltop down to one of the many creeks that cross the landscape in the upper parts of Imbarasan. The soils were more fertile than those of case study household IH5 and were of the *mestizo* (mixed) type in the local classification system.

Family attributes

The family consisted of an older, married couple. They were in their late 50's or early 60's. They had several children most of whom were married. None of them lived in Imbarasan / Himamara although one son and his family lived in an adjacent *sitio* nearer the road. The other children lived in other communities in the San Jose area and one son lived in San Jose town where he was employed as a furniture maker. Their youngest daughter was still in college in San Jose pursuing an associates degree in computer science.

Settlement and management history

The household was one of the second group of arrivals to the area and arrived around 1970 from Batangas province on Luzon. They were able to claim a large area and initially used a typical *kaingin* system based on annual crops, predominately maize and upland rice. Over the years they had expanded the area planted to bananas. They had tried a number of different varieties but had settled on *Saba*, a banana variety used primarily for cooking. They had had good luck with the variety and it had proven well suited to their soils. Their land was located in a protected valley and so they had been able to avoid the wind damage from typhoons that had been a semi-regular (every 5 years or so) problem for other banana cultivators in the area. In 1996, the had 4 hectares planted to banana and the remaining three hectares were in secondary forest fallow.

Current livelihood system

Their current livelihood system was strongly focused on banana cultivation although they had some livestock and had planted annual crops in past years.

Annual crops

They had a relatively flat section of their land that they prefered to plant to annual crops using a *kaingin* system. In past years they had made a *kaingin* on a small part of their remaining land to produce maize and *palay kaingin* for home consumption and had even plowed some of the flatter areas. However, they no longer owned a buffalo and, due to health problems, they felt that they would be unable to maintain a *kaingin*. In the words of the wife "*Kung hindi pwede magdadamo, huwag lang kaingin. Sayang sa oras mo.*", If you can't weed, don't make a *kaingin.* You are just wasting your time. They did not have the labor to do sufficient weeding during the study year and so did not plant either maize or *palay kaingin*.

Livestock

The household also raised some livestock. They had two cows that they were raising on share for a family in San Jose. The system was explained previously in the context of example household IH2. The cows and their offspring would eventually be sold, cows were perceived as far too valuable for home consumption. They household also had 10 goats and a number of chickens. The chickens were used for home consumption. They had recently sold one goat for P1000 and had given another to a relative for a christening.

Perennials

Their land management system was based almost exclusively on the cultivation of bananas (*Saba* variety). They estimated that they harvested between

1000 and 2000 pieces per week off of their approximately 4 ha of bananas. At a selling price of P50/100 pieces (a middle-of-the-road price), this produced a weekly cash income of between P500 and P1000 -- or a monthly income of P2000-4000. They harvested bananas year-round although there was usually less harvest between about September and December. The bananas were transported to town with the assistance of their son who lived in the adjoining *sitio* in return for a portion of the harvest.

Other activities

They were not involved in any other livelihood activities. Since they were both older and not in the best health, they did not work off farm. The wife was now making vinegar out of over-ripe bananas that could not be sold. However, at present it was only used for home consumption and limited amounts were given to relatives and friends. She did not sell it.

Estimated household budget

This household had a very simple budget since they had very specialized production (Table A2.10). During 1996, their only sources of income were from the sale of bananas and the sale of a goat. They may have been receiving some assistance from their children in the form of food (rice) or other items; however, they did not discuss this in interviews. In spite of their low income, they were financially solvent because their expenses were low. Their only significant expenses were for food and household needs and the school costs for their youngest daughter. Since they were only two people, their expenses for food and household items were low.

Table A2.10. Estimated household budget for example household IH6

Income	Amount	Expense	Amount
Bananas	36,000	School	9,000
Goat	1,000	Food	12,000
		Household	6,000
Total income	37,000	Total expenses	27,000
Net income	10,000		

Assumptions: Bananas 1500 pieces/week, P50/100 pieces; school P1000/child/month

Household IH7

Land

Their land was located in Imbarasan in the third set of hills. They had 3 hectares. All of it was sloping except for a small section (0.5 ha) that contained the house lot and two or three small fields. The soil on their land fell into the local category of *mestizo* soils. They had recently obtained use rights to a small parcel (approximately 1ha) of lowland in Bayombong, the *sitio* adjacent to Imbarasan that was located on either side of the main road.

Family attributes

The household was headed by a married couple who were both about 40 years of age. Their 7 children ranged in age from 19 to 1 year. Their oldest daughter graduated this year with an associates degree in business from the provincial college in San Jose. She would like to pursue her bachelors degree in accounting in Manila but family finances did not permit it at the time of the study. Their oldest son had dropped out of school to work full-time on the farm while their next four children all attended school (1 in high school in San Jose and 3 at the *barangay* elementary school).

Settlement and management history

The household was part of the second major group of migrants into the area and arrived in 1974 from Panay island. The purchased their land from one of the earliest settlers and obtained a CSC on their holdings through the ISFP. From the time they arrived in the area until 1990, they managed their land using the *kaingin* system typical to the area. They would clear and burn a section of their holdings and crop it for 1- 2 years, usually with maize. They inter-planted fruit trees and other perennials in the second year and left the area fallow. Assuming they cropped 0.5 ha each year for two years, this resulted in a fallow cycle of approximately 4 years. Using this cycle, they observed that their maize yields decreased over time. They also planted cassava on part of their holdings. In the late 1980's they had become very interested in the possibility of increasing the area of their land planted to perennials. They considered several different species including banana, mango, bamboo and melina. The DENR was promoting gmelina heavily in the area in the late 1980's and in 1989, they obtained a large number of seedlings free from the DENR nursery in Imbarasan. They were impressed with the tree growth on their land and began collecting seed from their now mature trees and multiplying their own seedlings. In the process, the wife had become recognized in the area as the local expert on melina propagation. Through this connection, they obtained work, starting in mid-1996, managing an 8 ha melina and mahogany plantation in *sitio* Bayombong. They relocated from their Imbarasan holdings to live at the plantation full time since it was closer to the elementary school. Some of the mature melina trees that they planted in 1989 were used as the building materials for their new house.

Current livelihood system

Their present land management system was heavily based on perennial crops including melina, fruit trees and bamboo. They had a few small livestock and cultivated a small amount of annual crops. The did not harvest any forest products other than those available on their own land, but they were highly dependent on off-farm labor to meet their cash needs.

Annual crops

Although annual crops were not the focus of the household livelihood system, they were a valuable component. On a flatter portion of their upland holdings near their house site, they planted approximately 0.5 ha of cassava. This could be eaten if necessary, sold or used as chicken feed. On the lowland parcel (1 ha) that they received as part of their agreement with the plantation owner, they planted *palay bukid* in rainy season and mung bean in dry season. The area planted, estimated yields and peso equivalent are shown in Table A2.11.

Table A2.11. Annual crops for example household IH7

Crop	Area (ha)	Yield	Yield/ha	Peso equivalent
Cassava	0.5	500 kg	1000 kg/ha	1,750
Rice	1	3000 kg	3000 kg/ha	24,000
Mung bean	1	600 kg	600 kg/ha	12,000

Assumptions: Cassava P3.50/kg, Rice P8/kg, Mung bean, P20/kg

Livestock

The household raised only a small amount of livestock. They owned one buffalo that was used for farm tasks. They also owned approximately 10 chickens that provided eggs and occasional meat for home consumption.

Perennials

They had planted about 1.4 ha of their land to melina trees on 1 m x 1 m spacing. They were managing these trees for timber production. They weeded between the seedlings in order to insure good establishment and early growth. They were pruning side branches to insure good quality timber in the bole and they were planning to thin the area in approximately 5 years. They would sell the small trees for posts at that time and allow the remainder to grow to full timber size. Based on the observed growth rates for melina on their land, they expected to have marketable timber in 10-15 years. They had also planted other perennials including mango, banana and bamboo. All of these species were targeted for primarily household needs; however surplus production could be sold. This was particularly true of bamboo where they had planted 30 clumps.

Other activities

As described earlier, they had moved off of their upland area and down to the *sitio* near the road and the elementary school. They had been hired by a man who had purchased 8 ha in Bayumbong, Mapaya for a melina and mahogany plantation. He was in the merchant marine and was planning for his retirement. He hired the husband at P70/day (P2100/month) to plant and care for the tree seedlings starting in January, 1996. In addition to salary, they gained access to this small section (1 ha) of lowland that they could use as they choose. It was part of the parcel that he purchased and was unsuitable for tree cultivation. They were also being paid for the melina seedlings that would be used in the plantation since the wife planted and raised them in her nursery.

Estimated household budget

At present, their household budget (Table A2.12) consisted of income from the sale of mung bean and from the husband's salary. The rice grown on their 1 ha of lowland and the cassava and fruits from their upland holdings were sufficient for home consumption. The income was sufficient to offset their household expenses, the largest of which were the costs associated with keeping 4 children in school. This estimated household budget did not reflect the potential value of their management system at some future time. Based on price and tree growth information they provided, I estimated the potential returns to 1 ha of melina cultivation as high as P3 million after 10 years.

Table A2.12. Estimated household budget for example household IH7

Income	Amount	Expense	Amount
Mung bean	12,000	Food	12,000
Off-farm employment	25,200	Household	6,000
		School	18,000
Total income	37,200	Total expenses	36,000
Net income	1,200		

Household IH8

Land

The household was cultivating about 1 ha of sloping upland in Himamara. He did not have any sort of formal claim to the land and believed that the paperwork necessary to get a CSC was a waste of time. His land was sloping, between 20% and 30%, but very fertile. He was in one of the best areas of *lupang puro* or pure soil in Himamara.

Family attributes

The household consisted of one person, a confirmed bachelor, now in his late 50's. He had some relatives including brothers and their families in the adjacent *barangay* of Paclolo (east of Mapaya).

Settlement and management history

The man was one of the first migrants into the area, arriving in 1956 from Roxas, Oriental Mindoro. He said that he had used basically the same *kaingin* or shifting cultivation system all along. He had focused on maize cultivation, preferring to obtain his rice through barter with other households who had lowland holdings. He worked off-farm for several years in the 1980's as a hired man for one of the neighboring households with lowland parcels but didn't like it so went back to *kaingin*.

Current livelihood system

The present livelihood system was based primarily on the cultivation of annual crops. He only owned a few chickens and had planted only a few fruit trees on his holdings. He harvested and sold some forest products, primarily charcoal.

Annual crops

In 1996, the farmer was growing native maize on his entire 1 hectare of cleared land. He was using the local variety called *Sabnit*, it was referred to as a *pula* (red) variety to differentiate it from the newer, more highly glutinous white varieties that were more common in the area. He typically harvested two crops of maize per year from his land. The first crop was usually planted in June and harvested in late August. This was followed by a second crop from September to December. This year, 1996, he planted early taking advantage of moisture from the unusual April typhoon. He used a low input system of no fertilizers or pesticides. However, since he lacked labor, he used herbicide to keep the weeds down. He said that herbicide was significantly cheaper than hiring others to do the weeding for him.

For his second crop last year (1995) he planted approximately 0.8 ha of maize and harvested 750 kg for a yield equivalent of 950 kg/ha. This yield was lower than average. In 1996, he planted 1 ha of maize and expects the yield to be about to 1500 kg/ha for the first crop and plans to repeat this for second crop for a total annual yield of 3000 kg/ha. Unfortunately, due to the peace and order problems in the area, I was unable to return to his holdings and determine his actual yield for 1996. He saved some maize for planting materials and for home consumption and traded maize to households in the adjacent lowlands for rice.

Livestock

At the present time, the farmer only owned a few chickens that provided eggs and occasional meat for home consumption. He did not own a buffalo. Although he did not explicitly say so, I inferred that he hired a buffalo to haul his products (maize and charcoal) out of the area.

Perennials

He did not actively manage any perennials although he had planted a few fruit trees in his *kaingin* fields. These trees produced some fruit for home consumption. He also harvested *ipil-ipil* trees from common areas further into the mountains from his holdings and made charcoal for sale. During 1996 he sold 100 sacks of charcoal.

Other activities

In 1996, the farmer did not engage in other livelihood activities although he had worked off-farm in the past. He said that at this point in his life, he was content with his situation and did not need additional income.

Estimated household budget

The household budget for this household was very simple. He traded maize to meet his rice requirements and sold a small amount of maize and some charcoal to meet his limited cash needs primarily for basic household necessities like coffee, sugar, salt, vinegar and soy sauce. The estimated budget is shown in Table A2.13.

Table A2.13. Estimated household budget for example household IH8

Income	Amount	Expense	Amount
Charcoal	4,000	Ag expenses (herbicide, hauling)	2,000
Maize	6,000	Household expenses	6,000
Total income	10,000	Total expenses	8,000
Net income	2,000		

Households in Halang

Household H1

Land

Example household H1 had use rights to two parcels of land. The first parcel was a small residential lot located outside of Halang in *sitio* Kambingan, *barangay* Bayugo. The second parcel was a 2 ha parcel of upland located in Halang proper. The household inherited the lowland parcel from the husband's parents and inherited the upland parcel from the wife's parents. At present, the house on the lowland lot was occupied by a family friend and was used by their children if they did not want to come all the way back to Halang after school. The lot was too small to be agriculturally productive beyond the cultivation of a few backyard vegetables. They had title to the lot in Bayugo and had received a CLOA for their land in Halang.

Family attributes

The household was made up a husband a wife, both in their forties and seven of their eight children ranging in age from 1 to 18. Their oldest daughter, who was 21,did not live in Halang. One of their children was in high school and one other child was in elementary school. The others had either finished school or were still too young to attend. The husband was from the lake-side parts of *barangay* Bayugo while the wife was the daughter of one of the original settlers in Halang.

Settlement and management history

The couple first moved to Halang when they got married in 1975. The husband and his family were fisherman. However, he had noticed that the fishing was getting steadily worse as he got older. When they got married, they accepted an offer of land from her father and moved up into Halang and started to farm. He still enjoyed fishing and went with his brothers and brothers-in-law when the opportunity presented itself; however, he said that he believed that the returns from farming were more stable. You were producing your own food (rice), and were not dependent on selling what you catch.

After taking over the land from her father, the couple managed the land using the typical, local short-fallow shifting cultivation system. They also planted significant numbers of fruit trees. The wife had some health problems and they were forced to relocate to Bayugo from 1984-1991. The husband was still farming a small portion of the land at that time but mainly worked off-farm as a carpenter, in order to meet medical expenses. In 1991 they moved back to Halang.

Current livelihood system

Their current livelihood system consisted of cultivating small fields of a variety of annual crops, some livestock, some fruit trees, making charcoal from locally available multi-purpose tree species in fallow and common areas and working off-farm as work was available.

Annual crops

As was typical of most households in Halang, household H1 planted four different small fields to annual crops. The area, yield, and approximate monetary equivalent of the various crops are shown in Table A2.14. The rice was used for home consumption, the other crops were sold. They used ammonium sulfate fertilizer on the taro, maize and rice. Peanuts were grown without fertilization. Taro, rice and the early peanut were all planted in May. The maize was planted in October, after the first peanut harvest, in the same field as the early peanuts. The second crop of peanuts were planted in a separate field in September. Household crop yields were slightly higher than the average yields for the community. But, as mentioned earlier, 1996 was a difficult crop year. As an example, this household reported a taro yield of approximately 100 sacks (5000 kg) per hectare in 1995 as compared to only 1200 kg in 1996.

Table A2.14. Annual crops for example household H1

Crop	Area (ha)	Yield	Yield / ha	Monetary equivalent
Taro	0.33	400 kg	1200 kg	P4,000
Rice	0.2	350 kg	1750 kg	P2,800
Maize	0.2	2500 ears	12,500 ears	P2,500
Peanut (May planting)	0.2	250 kg	1250 kg	P2,500
Peanut (September planting)	0.2	200 kg	1000 kg	P2,000

Assumptions: Taro P10/kg, peanut P10/kg, rice P8/kg, maize ears P1 each

Livestock

The household also managed some livestock. They owned 3 buffalo that they used as work animals for field preparation and for hauling. They also owned 4 cows that they were raising for sale. Cows were commonly used in this community as a semi-liquid form of savings. They were easily sold if necessary and the selling price was relatively consistent throughout the year. They could also be bred to produce additional animals and thereby increase household assets.

Perennials

The household also had a number of perennials including 20 mango trees, approximately 100 bananas and 60 newly planted bamboo clumps. They sold both mangos and bananas and also sold the pods from 3 tamarind trees located on their holdings. The tamarind pods were used as a flavoring for soups and as the raw material for a local candy. The bamboo clumps were not yet producing saleable products. The household also used a variety of multipurpose tree species as the raw material for both fuel wood for the household itself and charcoal for sale. They reported selling a total of 50 sacks of charcoal during 1996.

Other activities

Off-farm work was also an important source of cash income for this household. As mentioned earlier, the husband was a semi-skilled carpenter and was regularly employed in Bayugo during dry season on construction projects. He did not have the opportunity to work as much in 1996 as in past years since their house was significantly damaged by the typhoon Rosing in November, 1995 and he spent much of January-April, 1996 rebuilding it. The husband also contracted to plow agricultural fields with his buffalo and worked as an agricultural laborer when opportunities were available. The eldest son also worked in agricultural tasks.

Estimated household budget

Table A2.15 shows an estimated budget for example household H1. In spite of a relatively poor taro harvest, the household was able to stay out of debt. The importance of off-farm work and cattle were readily apparent. Sale of the cow financed the repairs on the house and the cash income from working off-farm covered the bulk of household cash expenses.

Table A2.15. Estimated household budget for example household H1

Income	Amount (pesos)	Expense	Amount (pesos)
Agricultural products	11,000	Food and household	40,000
Charcoal	1,750	House repairs	20,000
Sale of cow	17,500	School	3,000
Off-farm work	34,000	Agriculture	1,000
Total income	64,250	Total expenses	64,000
Net income	250		

Assumptions: Values based on survey and interview reports. Off-farm work estimated at 100 days of work at P200/day (average) for father; 100 days of work at P140/day for son.

Household H2

Land

Example household H2 had use rights to 3 hectares of sloping uplands on the ridge top close to the middle of Halang. The family house was located along the main road of the sitio. The household holdings extended up the slope to the north of their house. They had received a CLOA for their land as part of the agrarian reform process in Halang. The household originally had claim on a larger amount of land, but were limited to 3 ha under the agrarian reform program. An adjacent 3 hectare parcel of land was held by one of the older sons and his wife.

Family attributes

Household H2 consisted of a married couple, both 50 years of age, and their 4 unmarried sons. Their other two children were married. One of their daughters-in-law, married to the oldest son, was essentially part of the household because her husband was working for the power company and was assigned to various locations depending on company needs. The other married son and his wife resided with their infant son in a small house near his parents and managed an adjacent parcel of land. Three of their children were still attending school, two in elementary and one in high school.

Settlement and management history

Along with the vast majority of Halang residents, the couple who were the basis of household H2 were originally from Calaca, Batangas. The wife was the daughter of the second settler in the area. However, the household did not migrate directly to the area from Batangas. They left Batangas to settle in Mulanay, Quezon. However, they found Mulanay too far from everything for their taste and, hearing about this new area from her parents and siblings, decided to join them in Halang. They arrived in Halang in 1972 with two small children as one of the first few residents and claimed an unoccupied parcel of about 6 ha of land.

They initially made charcoal and slowly developed the *cogon* dominated landscape into productive annual crop fields as did the rest of the early arrivals to the area. Since that time, they had settled into a system of rotating small fields with taro, rice, maize, peanut and fallow. Their typical rotation was taro in the first year, rice-fallow in the second year, and maize-peanut (or peanut-maize) in the third and sometimes the fourth year. This sequence was followed by 3-5 years of fallow. They had noticed declining soil fertility and evidence of erosion on their fields over time but were not aware of any reliable methods to combat these problems except for the use of fallow periods. The head of the household was interested in options. The husband was one of the more active farmer participants in the SEARCA-UQ project and had a demonstration site set up on part of his land (approximately one-fifth of a hectare).

Current livelihood system

The current household livelihood system was based on a mixture of annual crops, livestock and perennials. The wife also rans a *sari-sari* store that provided additional income. As mentioned earlier, their oldest son who was working for the power company also contributed monetary support to the household since his parents were taking care of his wife and children in his absence.

Annual crops

Information on the major annual crops grown by the household was shown in Table A2.16. At present, they were managing 4 parcels, all approximately 0.25 ha in size. One parcel was planted to taro, the second to rice, the third to maize followed by peanut and the fourth to peanut followed by maize. They used ammonium sulfate fertilizer on their taro and rice and on their second crop of maize. Maize and rice were both grown for household consumption while taro and peanut were sold. Overall, the crop yields were similar to slightly above local averages. The first crop peanut yield was the highest reported for the area, while the second crop peanut yield was the lowest.

Table A2.16. Annual crops for example household H2

Crop	Area (ha)	Yield	Yield / ha	Peso equivalent
Taro	0.25	300	1200	3,000
Rice	0.25	200	800	1,600
Maize May planting	0.25	250	1000	1,625
Maize September planting	0.25	250	1000	1,625
Peanut May planting	0.25	600	2400	6,000
Peanut September planting	0.25	50	200	500

Assumptions: Maize yields are local average for that plot size and seeding rate. Prices are as follows: Taro, P10/kg; Rice P8/kg; Maize P6.50/kg; Peanut P10/kg

Livestock

The household also cared for several different types of livestock including buffalo, cows, goats and chickens. They owned one buffalo that they used as a draft animal. They also owned four cattle that could be used as draft animals and also could be sold if necessary. They owned four goats that were also being raised for sale. Their chickens were used as a source of eggs and occasionally as meat for household consumption.

Perennials

The household also made use of several types of perennials. Because of their exposed, ridge top location, their trees suffered severe damage from typhoon Rosing in 1995. The storm blew down 5 large mangos, destroyed 20 newly planted mahogany seedlings, and severely damaged their banana patch. However, they still had several perennials remaining. The five mango trees were damaged but still alive and they had received and planted 24 mango seedlings as part of the SEARCA-UQ project. They have sold the mangos they harvested in previous years and intended to sell the produce of the new trees once they reached bearing age. The household head was unwilling to invest his own money in new mango seedlings given the extensive typhoon damage, but he agreed to plant seedlings provided by the project. In addition to mango, they had approximately 100 banana plants, 5 jackfruit trees and 10 tamarinds. Fruits from all of these species were sold, although some were retained for home consumption.

In addition to fruit trees, the household had 8 mature bamboo clumps that provide materials for both home use and sale. Fifty mahogany seedlings survived the typhoon and continued to grow. They also used three multi-purpose tree species, leucaena, *aroma* (*Acacia farnesiana*) and camachile, as sources of household fuel wood and as raw material for charcoal that could be sold. They reported selling 150 sacks of charcoal during the past year. These trees came from the fallow sections of their land.

Estimated household budget

Based on the survey responses and interview notes, I developed an estimated household budget (Table A2.17). Off-farm work, in this case the son's employment, provided a significant portion of household cash income. Income from their small retail store and from the sale of charcoal was also important. However, livestock, and specifically cattle, provided the extra income necessary to overcome a marginally productive agricultural year and a significant amount of unusual medical expenses related to an illness suffered by the wife and for a c-section that his daughter-in-law required to safely deliver her child. The household experienced a significant drop in herd size over the course of the year (from 8 head of cattle to 4) but they were able to meet their expenses without going into debt.

Table A2.17. Estimated household budget for example household H2

Income	Amount	Expense	Amount
Agriculture	11,200	Food and household	54,750
Charcoal	5,250	Agriculture	1,000
Animals	43,500	Clothes	5,000
Sari-sari store	10,950	School	10,000
Off-farm work (son)	36,000	Medical Expenses	35,000
Total income	106,900	Total expenses	105,750
Net income	1,150		

Assumptions: Income and expenses from survey with added medical expenses and animal income to pay for them from informal interview notes.

Household H3

Land

This household had access to a larger area of land than the previous two households. The head-of-household had management control over 6 hectares. Although 3 hectares were officially held by his teenaged son, the father managed the land as a unit and stated that he had no intention of giving up management control anytime in the near future. This land was some of the best in the *sitio*. It ran from the ridge top down into the main valley on the west side of the area and extended on both sides of a small, intermittent stream. As a consequence, unlike residents who lived on the ridge top, much of household H2's land was sheltered from the brunt of major typhoons that come out of east. Their house and perennials only sustained minor damage in typhoon Rosing. They had obtained CLOA's for the parcel. The father officially held one CLOA for three hectares and the sixteen year old son another for the remaining three.

Family attributes

The household consisted of a married couple, both in their mid-forties and their seven children ranging in age from 1 to 21 years. None of their children were married. Their oldest daughter graduated in 1996 with an associates degree from the provincial college in Tanay and another daughter had just finished high school. The oldest son decided not to attend high school and worked full-time with his father on the farm. Three of the younger siblings were still in school, 2 in elementary and 1 in high school.

Settlement and management history

As was typical with this group of households, the husband was a member of one of the earliest families to settle in the area. He arrived with his father and brothers in 1971 (he was in his early twenties). He claimed the parcel of land that made up the center of current household land holdings and developed the land following the same procedure as other early settlers. He had, however, placed more emphasis on fruit and especially timber species than other residents. This was due, at least in part, to his location. Much of his land on both sides of the stream was steeply sloping and was ill suited for annual crops. In addition, as mentioned earlier, their land was well protected from typhoon winds. However, location was not the entire story. During informal interviews, the household head talked repeatedly about the importance and value of perennial species.

The couple were married in 1976. The wife was also from Calaca, and they settled in Halang. Since that time, they had been able to purchase two parcels adjacent to their holdings from other early settlers in the area. They continued to manage their land using the typical short-fallow system in the area; however they continued to increase and diversify their perennial holdings.

Current livelihood system

The current household livelihood system included the four major components common to all three households in this larger group: annual crops, livestock, perennials and off-farm work. However, this household placed much more emphasis on perennials, although this was not necessarily apparent from the snapshot results provided by the formal survey.

Annual crops

This household grew the typical mixture of annual crops in the area (Table A2.18). Taro was grown on the most recently cleared hillside plot. *Palay kaingin* (variety R-1) was grown on a hilltop parcel. This location, with well-drained, sandy soils, was strongly affected by the unusual drought conditions during June, July and August leading to the extremely low rice yield. Maize and peanut were both planted in May and a second crop of peanut was planted in September, following the maize harvest. They applied ammonium sulfate fertilizer to their taro, rice and maize. Peanut was grown without fertilization. Peanut and taro yields were both above community averages; however taro yields community wide were much lower than in previous years. It was an average-good year for peanut. What little rice was harvested was saved for next year's seed. Maize was used for home consumption while peanut and taro were both sold.

Table A2.18. Annual crops for example household H3

Crop	Area (ha)	Yield (kg)	Yield (kg / ha)	Peso equivalent
Rice	0.5	50	100	400
Taro	0.5	1500	3000	15,000
Maize	0.25	150	600	975
Peanut (May)	0.25	450	1400	4,500
Peanut (September)	0.25	450	1400	4,500

Assumptions: Maize yield based on community averages for area and seeding rate.
Prices: Taro P10/kg, peanut P10/kg, maize P6.50/kg, rice P8/kg

Livestock

The household also cared for some livestock. They had one buffalo that they used as a draft animal. They also had 3 cows that could be used as draft animals and could be sold as necessary to raise cash. They had two goats including a breeding doe. The young goats were sometimes used for home consumption but primarily were sold. They had a few chickens to provide eggs and occasionally meat for the household. They sold at least 1 cow and 2 goats during the past year in order to meet the food and household expenses.

Perennials

As mentioned earlier, the head of this household repeatedly stressed the desirability and importance of perennial species in discussions and cultivated a mixture of species on their land holdings. Fruit trees were an important component of the system including mangos, tamarind, jackfruit, guava, sweetsop and bananas, although the household managed fewer bananas then other households in the area. All of these fruits were sold and could be used for household consumption. They had also planted a small area to coffee but had not harvested any marketable yield.

Aside from fruit trees, the household made use of a variety of non-fruit species. This was the only household that reported growing and harvesting timber (in this case *Albizzia saman* (monkeypod, locally known as *acacia*) for home construction. He had replanted *acacia* and had planted at least two other timber species, mahogany and ipil (*Intsia bijuga*). With this wood from their land, which they had sawn into boards for siding, and with *ipil-ipil* from their land for use as small timber, they were able to construct a nice house for only P30,000 in cash. The cash was spent primarily on cement, nails and metal sheeting for the roof. In addition to the timber species, the household harvested the typical mixture of multi-purpose trees (*aroma*, *ipil-ipil*, camachile) for use a fuel wood and in order to make charcoal for sale. They reported selling 200 sacks of charcoal during the past year.

This household also managed their perennial species a bit differently than other households in the area. The head of the household believed that the best way to manage perennials was to mimic the natural forest. As a consequence, he inter-planted the different fruit trees with forest species and allowed the small, multi-purpose species to fill in the gaps. These smaller trees were always there. They could be cut as necessary to reduce competition with the more valuable species, for use as household cooking fuel, or as the raw material for charcoal that could be sold. He said that, by using this strategy, he may be sacrificing yield (of mango for example) in good years, but none of his mango trees blew down in typhoon Rosing either. This system also provided him with a wide variety of tree products at any given time and pretty much guaranteed something under any circumstances.

This emphasis on tree crops went hand in hand with the head-of-household's repeated discussion of the importance of having land. In my last interview with him he said (paraphrased and translated): "Money can't replace land. If you have land and know what you were doing, you can make money and you will still have the land afterwards. If you sell the land for money, then you will only have money." It was very important for him and his wife that they had productive land to give to their children. They saw perennials as the best way to keep the land productive over the long term in addition to providing other benefits such as marketable products and shade.

Other activities

The household did benefit from some, non-farm activities. Both the father and son worked off-farm as day laborers when work was available. This was likely be particularly important in the coming year (1997) due to the problems they had with their annual crops, particularly rice. They will likely be forced to buy rice to eat until the next harvest in late 1997.

Estimated household budget

Table A2.19 shows an estimated budget for household H3. The costs for house remodeling discussed above were covered by the returns (estimated at P50,000) from a good taro crop harvested in early January and were not included in this budget. In addition, education expenses in 1996 were much less than in 1995 since their oldest daughter finished her college studies. Carry-over funds from the previous year's taro harvest provided the money necessary to make up the shortfall evident in this year's budget. However, as mentioned earlier, the extremely poor rice yield in 1996 was likely increase food and household expenses even more in 1997. The household was likely to respond to this situation using a mixture of strategies including selling cattle, making and selling more charcoal, and increasing the amount of time that both father and son work off-farm. They also hoped that their oldest daughter would be able to make use of her college degree to find a good job that would provide additional cash income for the family.

Table A2.19. Estimated household budget for example household H3

Income	Amount	Expense	Amount
Agriculture	22,800	Food and household	109,500
Charcoal	7,000	Agriculture	3,000
Livestock	19,000	Clothing	2,500
Off-farm work	30,000	School	4,000
Total income	78,800	Total expenses	119,000
Net income	-30,200		

Assumptions: All expenses as noted in survey responses.

Household H4

Land

Example household H4 had access to 3 hectares of rainfed land. It was located on the river plain in the southeast corner of the sitio and ranged from flat to steeply sloping as one proceeded away from the river. Even the flat parts of his holdings were over 100m from the river and it was not economical at present to flood the area for *palay bukid* cultivation. The husband inherited the land from his parents and managed to retain a significantly large parcel because he was the only one of his nine siblings who was interested in farming in Halang. He had clear title to the parcel since it was in the only part of Halang that was not part of the three original cattle ranches.

Family attributes

The household was small and consisted of a recently married couple who had no children. The husband was in his early 30's and the wife in her late 20's. Unlike most sitio residents, both the husband and wife were high school graduates.

Settlement and management history

The husband returned to manage the area in 1992 after having spent his high school and bachelor years living and working in Bayugo and in Manila Most of his family, including his parents, still lived in sitio Kambingan. The land was originally settled by his paternal grandparents in the 1940's. His family had been managing the parcel ever since. His father managed the land for annual crops until relatively recently and had continued to manage various perennial crops all the way through. But, no annual crops had been planted for several years prior to thehis return to Halang. He commuted to the area from Bayugo while he and his wife were dating but they settled in the area to stay in 1996. His wife was originally from Bulacan province, just north of Manila.

Since his return, he had added two variations to the typical small field, short fallow dominated system. First of all, he had agreed to participate as a cooperating farmer with the SEARCA-UQ project. The project had planted perennials on one of his sloping fields and was trying out a number of different potential crops and management strategies. Secondly, as part of the project, he traveled with a group of farmers to Cebu province in the central Philippines to look at what farmers there were doing to address erosion problems in their fields. Since his return, he had planted hedgerows (primarily *Desmodium rensonii*) between the small fields on the relatively flatter portions of his holdings (10-25% slope). He was also convinced that he should keep steeper parts of the land in perennials.

Current livelihood system

The current livelihood system for this household was based on annual crops and perennials. They owned only a small number of livestock and they did not work off-farm.

Annual crops

The household cultivated small areas of all of four major crops grown in Halang (rice, maize, taro and peanut) (Table A2.20). Because their land was in a lower spot than most sitio holdings, they had better soil moisture status in spite of the June-August drought. As a consequence, their *palay kaingin* yields were among the highest recorded in the sitio Their favorable location also contributed to their much above average yields for second crop maize. Their first crop maize was destroyed by a combination of drought and insect problems. Yields for both taro and peanut were below sitio averages but well within the range of reported yields. The household head reported that in 1995, taro yield was considerably higher. Their rice yield in1995 was also much higher since they were able to plant a flooded field (*palay bukid*). The rains were so late and scattered in 1996 that he planted *palay kaingin* instead. The household planned to use the rice for food and to keep the small peanut harvest for next year's seed. They sold the taro and part of the maize although they also used some maize for home consumption.

They were one of the few households in the area that did not use chemical inputs, either pesticides or fertilizers, on any of their crops. The soils on their land area were alluvial and generally more fertile than the shallow soils that dominated the upland portions of the *sitio*.

Table A2.20. Annual crops for example household H4

Crop	Area (ha)	Yield (kg)	Yield (kg/ha)	Peso equivalent
Rice	0.125	300	2400	2,400
Maize (May)	0.125	0	0	0
Maize (Sept)	0.125	575	4600	3,740
Taro	0.1	150	1500	1,500
Peanut (Oct)	0.1	50	500	500

Assumptions: Prices: rice P8/kg, maize P6.50/kg, taro P10/kg, peanut P10/kg

Livestock

As mentioned above, the household had a small number of livestock. They had three buffalo but only one was of working age and could be used as a draft animal. They also just purchased a calf. They had a few chickens that were used for eggs and occasional meat. They were not selling any livestock at this time but the purchase of a calf indicated that they may be thinking of increasing their investment in livestock in the future.

Perennials

The household also managed significant amounts of perennials, both fruit trees and multipurpose species. Their primary crop was bananas (at least 100 plants). They grew mainly the *Saba* variety and had had few problems in the past. Unfortunately, their land was located on the east-facing slope of the hills and so was right in the path of typhoon Rosing. Although the storm did not kill many banana plants, it damaged them severely and significantly delayed and reduced this year's harvest. In addition to bananas, they had mangos and tamarind trees and had planted a small amount of coffee. The mangoes and tamarind pods were sold while the coffee was for home consumption at present. They had also recently planted 2 bamboo clumps. As part of the SEARCA project, they were managing newly planted mango (24), cashew (18), avocado (19) and bamboo (8) seedlings.

In addition to the fruit species, the household used the typical mixture of multi-purpose tree species for household fuel wood and as the raw material for charcoal to sell. They sold 50 sacks of charcoal last year. These trees came primarily from the fallow portions of the household land holdings.

Other activities

Since the household consisted of only two people, activities related to the management of their own land took up most of their time. In addition, as a young couple with no children, their living expenses were comparatively low. As a consequence, neither the husband or wife worked off-farm.

Estimated household budget

As might be expected, the magnitude of the figures in the estimated household budget for household H4 (Table A2.21) were much lower than for the three previous example households. This household simply did not have the magnitude of either expenses or income that the larger, older households possess.

Table A2.21. Estimated household budget for example household H4

Income	Amount (pesos)	Expense	Amount (pesos)
Agriculture	12,000	Food / Household	18,000
Banana	7,200	Agriculture	500
Charcoal	1,750	Clothes	500
	20,950	Health care	1,200
Total income	20,950	Total expenses	20,200
Net income	750		

Assumptions: Data as reported in survey, food/household estimated at P1500/month, health at P100/month

Household H5

Land

Household H5 had access to 1 hectare of land located across the road from the husband's father's holdings near the center of the sitio. Approximately one-half of the land had extremely steep slopes (nearly 100%) while the other half had more gentle slopes. The husband of the household inherited the land from his father when he got married and had received a CLOA for his holdings from the DAR.

Family attributes

The family in example household H5 was a nuclear family. Both the husband and wife were in their early 30's. They were the children of two of the earliest families to settle in Halang. The husband arrived with his family in 1971 and the wife in 1975. Both were originally from Calaca. As a consequence, they were related to most households in the sitio. They had 5 children ranging in age from 13 to 4 and including a set of twins. Four of the children attended school. The oldest daughter was in high school and the three middle siblings were all in elementary school. The daughter attended the Catholic high school in Jajajala while the younger children attended the local elementary school in Bayugo.

Settlement and management history

The husband came to the area as a boy with his family and helped his father to clear the area of cogon grass and cultivate annual crops and perennials using the typical local system. He inherited the small parcel he now owns and had managed it in the past using the common short-fallow based system. Since the parcel was so small, this had resulted in a cropping - fallow sequence that involved even less fallow time than was commonly used in Halang. In order to meet household needs, they needed to have approximately one-half of their holdings planted to annuals in any given year. In spite of this constraint, they have also planted a variety of perennial fruit species. In an attempt to further diversify their system and potentially increase their income, they purchased (for P25 each) and planted 25 grafted mango seedlings in 1995. Unfortunately, all were destroyed by typhoon Rosing in November.

Current livelihood system

The current livelihood system used by household H5 was based on the cultivation of annuals, some small livestock, and the cultivation and use of various perennial species. Although neither the husband or wife worked regularly off-farm for wages, the wife engaged in a small amount of petty trading (e. g. buy fish at the lakeshore and then resell it at a slightly higher price in the sitio) on an irregular basis.

Annual crops

The household made intensive use of their small holdings though planting small areas of several annual crops, rice, maize, taro and peanut (Table A2.22). Maize yields were slightly above local averages while rice and peanut yields were slightly lower then local averages. The taro yields reported by this household were the best in Halang and unusually high for 1996 (although not unusually high over the long term). The slightly improved maize yields might have been the result of their planting maize on a newly cleared parcel of land instead of the traditional practice of planting it on fields already cropped to taro for one year. They also applied ammonium sulfate fertilizer to their taro, rice and maize. The bulk of the fertilizer was applied to the taro. They used an interesting management strategy to capture any fertilizer runoff. They planted their taro on the upper part of the slope and then planted *palay kaingin* in the field downslope from the taro. The rice caught any nutrients (especially nitrogen) that ran off the taro patch. The rice was used strictly for home consumption. Maize was used for both home consumption and sale. Some the peanut was saved for seed and the rest was sold. The same was true for the taro.

Table A2.22. Annual crops for example household H5

Crop	Area (ha)	Yield	Yield /ha	Peso equivalent
Rice	0.2	150 kg	750 kg/ha	1,200
Maize (May)	0.15	2000 ears	13,300 ears/ha	2,000
Taro	0.25	1650 kg	6800 kg/ha	16,500
Peanut (May)	0.2	75 kg/ha	375 kg/ha	750

Assumptions: Prices rice P8/kg, maize P1/ear, taro P10/kg, peanut P10/kg

Livestock

In addition to annual crops, the household raised some livestock. They had a buffalo and a cow that were both used primarily as draft animals although the cow could conceivably be sold for meat if absolutely necessary. They had two goats (a breeding pair) and sold the kids for meat when they reached marketable age. They also had a few chickens that provided eggs and occasionally meat for home consumption.

Perennials

Example household H5 also used a variety of perennial species. In spite of the loss of 20 seedlings to the typhoon, the household had another 20 mango trees along with 30 soursop trees and a large banana patch. They also had a small number of tamarind and santol trees. All of the fruits produced were used both for home consumption and for sale. In addition to the fruit species, the household made use of common multi-purpose tree species (*aroma*, *ipil-ipil*, *kakawate*, camachile) for household fuel wood and for charcoal. They sold 20 sacks of charcoal during the past year.

Other activities

Given that their children were small and still in school, this household did not have any extra labor. As a consequence, the husband was occupied nearly exclusively with tasks on their land. However, as mentioned earlier, the wife did some small-scale trading, primarily of fish, that provided the household with supplementary income.

Estimated household budget

The estimated annual household budget for example household H5 is shown in Table A2.23. This household shows a negative net income for 1996. I believe that there were two major contributing factors that have caused the household to be unable to meet expenses. They were: the extremely poor peanut harvest that left the household without its second source of cash and the increased school expenses associated with the switch of their daughter from the public elementary school to the Catholic high school. Although it was likely that surplus funds from 1995 (a good crop year) can be used to cover the deficit in 1996 and to keep the household out of debt, it appears that the household needs to intensify existing income generating strategies (such as charcoal making) or to identify potential new income earning opportunities such as off-farm labor or an expansion of their small trading business.

In any case, with a number of growing children, their expenses were unlikely to go down anytime in the foreseeable future.

Table A2.23. Estimated household budget for example household H5

Income	Amount (pesos)	Expense	Amount (pesos)
Agriculture	16,200	Food / household	24,000
Charcoal	700	Farming	2,500
Trading	6,000	Clothing	2,000
Livestock	900	School	7,000
Total income	23,800	Total expenses	35,500
Net income	-11,700		

Household H6

Land

The only land available to household H6 was a small parcel of sloping upland with an area of 0.25 ha. They had been given this land to use by a friend and had no official claim on the parcel.

Family attributes

Household H6 was a nuclear family. The husband and wife were both in their mid-forties. They had a total of 13 children ranging in age from 3 to 22. Nine of them still lived at home. Two of the children at home were attending elementary school.

Settlement and management history

This household were relatively late arrivals in Halang. They arrived in 1982 from Mulanay, Quezon but were originally from Calaca, Batangas. They were related to several local residents at the level of aunts, uncles and cousins. Since they were late arrivals in the area, they had difficulty securing land in the populated sections of the sitio. Instead of settling and claiming a parcel of unused land further into the hills to the northeast, they had chosen to live near other residents and made use of the common sitio lands for cattle fodder and raw materials for charcoal. When they were interviewed in early 1996, they discussed plans to plant some annual crops on the small parcel near their residence. However, these plans fell through with the mid-season drought.

Current livelihood system

The current household livelihood system was based on livestock and multi-purpose tree species and also included cash income from off-farm labor.

Livestock

The household had three cows that it was caring for under the typical share-raising arrangement in the area. Under this arrangement, the owner provided the cow and the care-giver provided the daily care including fodder and water. The owner usually took care of any veterinary expenses. If the cow was bred, the owner got the first calf and the care-giver the second. If the cow was only being raised to be sold, the owner and care-giver generally split the sale proceeds when the cow reached market weight. In addition to caring for cattle, the household had a few chickens for home consumption as eggs or meat.

Perennials

On their small holdings, the household had planted 5 mango trees. At the time of this study, these trees were just reaching fruiting age and so the small amount of fruit produced was used only for home consumption. Once the trees mature and increase production, increasing amounts of mango could potentially be sold. Their primary source of livelihood cames from making charcoal from the assortment of multi-purpose tree species found on the common lands in the sitio. They used wood for their household needs and made charcoal for sale. In 1996 they reported selling 1000 sacks of charcoal.

Other activities

The father and two sons all worked off-farm as agricultural labor if work was available. This was a significant source of cash income for the household.

Estimated household budget

Household H6 had a simple annual estimated household budget (Table A2.24). Charcoal and off-farm labor provided nearly all of the household income and basic living costs dominated household expenses. This estimated budget shows the household basically breaking even for the year. However, it does not show the high level of vulnerability that households such as this one had to unforeseen expenses such as medical bills. Where another household with more resources (e.g. cattle, land) could generate or borrow money to meet expenses, households such as this one had a much more difficult time.

Table A2.24. Estimated household budget for example household H6

Income	Amount (pesos)	Expense	Amount (pesos)
Charcoal	35,000	Food / Household	66,000
Off-farm labor	30,000	School	2,650
Firewood	3,000	Clothes	1,000
Total income	68,000	Total expenses	69,650
Net income	-1,650		

Assumptions: Off-farm labor, 3 men, 100 days, P100/day; Food / Household 5,500/month; others from survey

Household H7

Land

Household H7 had access to 5 hectares of land. One-half hectare was located in one of the lakeside sitios of Bayugo and was served by a newly constructed irrigation system. The remaining 4.5 hectares were located in sitio Halang and were divided into 3, roughly similar sized parcels. The household purchased the lowland site and two of the upland parcels with the money the head of the household made working in the Middle East.

Family attributes

The household consisted of a married couple, both in their mid-forties and their 3 children who ranged in age from 24 to 19. Only the youngest son was still living at home. The oldest son was married and lived in Bayugo. He was the primary driver and collected income from the family *jeepney*. Their daughter finished an associates degree at the provincial college in Tanay and lived in the Manila area. Their youngest son just graduated from the provincial college in 1996 with an associates degree in commerce. The husband and wife came to Halang as a young married couple in the early 1970's along the husband's father and brothers. They were both from Calaca, Batangas.

Settlement and management history

The couple settled in Halang and claimed land near the husband's parents and brothers' holdings. As with all of the original settlers, they took advantage of the residual timber for charcoal and the high fertility of the newly cleared soils. The principal difference between this household and others was that the husband went off to work in the Middle East for several years in the late 1970's and early 1980's. He was able to save a considerable amount of money during that time and he had invested that money in a large concrete house in Halang, land in Halang and in Bayugo, and a *jeepney*. With these resources, the household had been able to insure that they meet their livelihood needs and had been able to send two children to college.

Current livelihood system

The current household livelihood system was based on annual crops, including *palay bukid* (two crops/year), livestock and perennials. As mentioned above, the family *jeepney* provided a source of livelihood for the oldest son and was also used to transport household products to market and crop inputs from town thus assuring that they got the best possible price.

Annual crops

The household grew the typical mix of annual crops in the area, with the notable exception that their rice was *palay bukid* with access to irrigation water if necessary instead of *palay kaingin* completely dependent on rainfall for moisture (Table A2.25). As a consequence, they were able to grow more than enough rice for home consumption and were able to sell a significant amount. As mentioned above, their rice yields were by far the highest in the community because they had the best lowland parcel and also used significant amounts of fertilizer, both ammonium sulfate and urea. Their maize and taro yields were also well above community averages. This was also likely due to the use of higher than average amounts of fertilizer. Their peanut yields were average for the area. They sold most of their peanut and taro and a portion of their maize. The remainder of the maize was used for home consumption.

Livestock

The household livelihood system also included some livestock. They had one buffalo that they used for animal traction in both *palay kaingin* and upland cultivation. They also had one cow that they used for animal traction in upland fields. They raised cattle for sale and sold 2 cows in 1996. However, they had not replaced these animals when the survey data was collected. They also had a few chickens for home consumption as eggs and occasional meat.

Table A2.25. Annual crops for example household H7

Crop	Area (ha)	Yield (kg)	Yield/ha	Peso equivalent
Rice (May crop)	0.5	2500	5000	20,000
Rice (Nov crop)	0.5	2500	5000	20,000
Taro	0.5	2000	4000	20,000
Maize (May)	0.5	900	1800	5,850
Maize (Sept)	0.5	900	1800	5,850
Peanut (May)	0.5	500	1000	5,000
Peanut (Sept)	0.5	500	1000	5,000

Assumptions: Prices: rice P8/kg, taro P10/kg, maize P6.50/kg, peanut P10/kg

Perennials

Perennial species also formed a part of their livelihood system. They had 50 mango trees and smaller numbers of bananas, papayas and tamarind. The mangos, bananas and tamarind pods were all sold and small amounts were used by the household. The papayas were solely for household consumption. They also had 50 bamboo clumps that they used for household needs and had recently planted 5 mahogany seedlings. The fallow parts of their land were covered with the typical local mixture of multi-purpose trees including *ipil-ipil*, *kakawate*, *aroma*, and camachile. They used the tree coppices and the wood from areas cleared for annual crop cultivation to provide household fuel wood and charcoal. In 1996, they did not make the charcoal themselves. Instead they contracted with one of the poorer sitio residents to do the work and they took a portion of the proceeds.

Other activities

As mentioned above, the household did not engage in any other livelihood activities themselves although they benefited from off-farm activities of others including their son, who provided free transportation to and from Manila and the share arrangement mentioned above for charcoal making.

Estimated household budget

As was apparent from Table A2.26, this household had a much higher cash flow than others in the area. This included having significant expenses associated with their son's college attendance. However, he graduated in 1996 so those expenses will not be important in future years. Their high earnings from agriculture were a reflection of the lowland rice yields as well as the price advantage they got for taro and peanut by being able to market them directly in Manila. They also were able to avoid borrowing money for any reason, including for agricultural expenses.

Table A2.26. Estimated household budget for example household H7

Income	Amount (pesos)	Expense	Amount (pesos)
Agriculture	95,000	Food / Household	43,700
Charcoal (share)	3,500	Agriculture	9,500
Cattle	35,000	Clothing	2,000
Fruits	4,000	School	70,000
Total income	137,500	Total expenses	125,200
Net income	12,300		

Household H8

Land

This management system required a lot of land and this household had control over a total of 15 ha in Halang. They avoided the 3 hectare limit under the agrarian reform program by titling the land in 3 hectare sections to 4 of the children (all adults, 3 of whom did not live in the area). Only one child continued to reside with his parents in Halang and he and his father managed the entire land holdings.

Family attributes

Unfortunately, the household was not in Halang when the survey was conducted so this description was based only on interview notes. The head of household suffered a heart attack in early 1996 and so I was only able to talk to him and his wife twice and his son one additional time during my work in Halang. The household consists of a husband and wife, both in their late 50s and their youngest son who was in his early 20's. They had several other children who lived in nearby towns. At least two of them were married. They arrived in Halang in 1972 as one of the first families. They were also originally from Calaca, although the wife grew up in northern Mindoro.

Settlement and management history

They settled the area in the early 1970's and claimed two significant parcels of land (one about 8 ha and one about 7 ha). They originally cleared the land, made charcoal out of the vegetation, and planted annual crops. However, since soon after their arrival they had been actively converting parts of their land (now at least 5 ha) into a managed forest dominated by *ipil-ipil*. Using the earnings from charcoal they were able to buy increasing numbers of cattle. They parlayed their cattle earnings into high school and college educations for their children and into a *jeepney*. They were the only household in the area that had been able to afford the cost of installing electricity. They had managed their forest holdings on a 2-3 year coppice rotation for several years previous to this study. They made charcoal out of the stems and used the leaves as cattle feed. They noticed that a 2-3 year rotation produced the best returns. They observed reduced vigor in older *ipil-ipil* trees. The remainder of their land was in brushy fallow and also managed for charcoal and fodder. They had grown annuals in the past but simply did not have the labor available at the time of this study.

Current livelihood system

Their current livelihood system was a continuation of the system they had followed in recent years using multi-purpose tree species, primarily leuceana as cattle fodder and as the raw material for charcoal production. Since the father had his heart attack, the only son remaining in the area had taken over virtually all of the day-to-day management activities.

Livestock

The household owned a significant number of cattle (at least 10). Most of the cattle were given to other, poorer *sitio* residents to raise on a share basis. Those cattle that were exclusively the property of the household were cared for by a local teenager who had been hired to do the job.

Perennials

The other major component of the management system were perennial species, specifically multi-purpose trees. They harvested different forested sections of their land in rotation. They made charcoal out of the stems, and used the leaves for fodder. Since this household was extremely labor poor, they hired other *sitio* residents to work for them making charcoal in return for a share of the proceeds. They preferentially concentrated on the 5 ha of land that they had planted to *ipil-ipil* but also managed the remainder of their brushy (*aroma* dominated) fallow land in a similar manner. The son was also interested in planting more timber species, primarily mahogany, on the currently fallow portions of their land holdings.

Other activities

The major other activity that contributed to household livelihood was the operation of a *jeepney*. The *jeepney* was stored in Bayugo and was driven by either the youngest son (who lived in Halang) or by one of his brothers. The parents retained a share of any income from the *jeepney* in addition to having it available to provide free transportation of household products (charcoal) directly to Manila.

Estimated household budget

Since I did not discuss financial details in any of my interviews, this estimated budget is a very rough estimate. Taking an approximate annual biomass grown increment for Leuceana of $30m^3$/ha (Vietmeyer and Cottom, 1977) and an average conversion ratio for Philippine charcoal production of 45 m^3 wood / 3650 kg charcoal (CFC, 1985) and the 1996 local price of charcoal (P1.5/kg) led to approximate annual returns of slightly over P10,000/ha for leucaena managed on a 3 year rotation. Taking this amount as a first approximation and assuming that the household had 12 hectares of land managed for charcoal on a three year rotation (4 hectares harvested each year) led to an annual return of P40,000 from charcoal production alone. Assuming they split these returns with the people doing the labor, this still left P20,000 per year in income. Full grown cattle sold for approximately P15,000 each. If the household sold 3 cows each year this would return an additional P45000 in income. Their share of income from the *jeepney* was also likely to be in this same range.

Since the household was small, their living expenses were relatively low. However, they needed to purchase all of their food. The Philippine Statistical Yearbook for 1997 estimated urban family expenditures at P91,000 / year. Since the household did not produce their own food, this seemed to be a more appropriate figure than the much lower figure for rural households (P44,000). With a moderate amount of income from the *jeepney*, the household could easily meet typical expenses under this system. As mentioned earlier, the household had significant medical expenses in 1996 associated with the father's heart attack and subsequent hospital stay. They met these expenses (on the order of P100,000) through a combination of money provided by employed children and the sale of two additional cattle.

Households in Upper Magsaysay

Household UM1

Land

The household asserted use rights over a total of 30 hectares of upland, all steeply sloping. One of the parcels was located adjacent to their house lot in KM 12. The second and third were further into the mountains in KM 12 and the fourth was in *sitio* Kakawayan. When they arrived in the area, no one was using the land and so they claimed it through improving the area. They reported holding a Certificate of Stewardship Contract (CSC) to their holdings, but did not specify which portion or portions were covered by the CSC. The entire area cannot legally be covered since the maximum allowable area for a CSC was 5 hectares.

People

Household UM1 was made up of a married couple, both whom were around 50 years old. They had 6 children ranging in age from 27 to 10. The four youngest children still resided with their parents. The two youngest children were attending school. One child attended high school in Infanta while the youngest child attends the local elementary school in Kakawayan. They had several relatives in the area including siblings and cousins.

Settlement and management hwastory

The couple moved to KM 12 from Kakawayan in 1975. The husband was originally from the Bicol region of southern Luzon and came to the area with his family in the 1950's (he was a small child). The wife was originally from the Infanta area. The originally moved to KM 12 looking for land to farm. They used the typical management sequence to clear the area. This sequences began with clearing the secondary forest left after commercial logging. The slash was burned and *palay kaingin* was planted in the area during the first year. During the second year cassava was planted and coconut palms were planted in the cassava field. After two or three years, the land was left to fallow. The area around the coconut seedlings was cleared in order to reduce competition but otherwise the area was lightly managed until the coconuts reach productive size. They now have several hectares of coconut palms. They regularly sold copra in the past but the market had dried up and the price had fallen drastically in the last several years. They had planted citrus trees under one of their older coconut orchards, but the citrus trees were not bearing yet.

Throughout their time in KM 12, they had been harvesting and selling residual timber from their lands and increasingly from common areas further into the mountains. They had also used the local timber to construct a large, wood-framed house in the settlement area of KM 12.

Present livelihood system

Their present livelihood system was basically a continuation of the past livelihood system. Since abundant land was still available, the household continued to use a long-fallow *kaingin* strategy. They also had planted perennials and continued to harvest timber.

Annual crops

At the present time, the household was cultivating two annual crops. They planted approximately one-half hectare of *palay kaingin* and one-half hectare of ginger. Crop yields (Table A2.27) were lower than community averages for both crops. They reported that rice yields declined drastically when planted more than once in an area. Ginger yields, however, remained relatively constant. Both crops were planted in unplowed fields with a dibble stick (rice) or piece by piece for ginger. They used neither fertilizers nor pesticides on either crop. The rice was used for home consumption. Ginger was grown primarily for sale.

Table A2.27. Annual crops for example households UM1

Crop	Area (ha)	Yield (kg)	Yield/ha	Peso equivalent
Upland rice	0.5	100	200	1,000
Ginger	0.5	250	500	5,000

Prices:Upland rice P10/kg, ginger P20/kg

Animals

As with most households in Upper Magsaysay, example household UM1 only had a small number of livestock. They owned one buffalo that they used for hauling timber and other supplies. They also owned a small number of chickens that provided eggs and occasionally meat for household consumption. They owned two dogs and two cats for security and rodent control respectively.

Perennials

The household had planted and was managing perennials on their land. They had significant numbers of coconut (approximately 300) and citrus (approximately

100) trees. They also had small numbers of other fruit trees, jackfruit, santol and avocado, and forest trees, Philippine mahogany (*narra*) and melina. They sold copra in the past but had not recently due to the extremely low price. They also had very low coconut yields in 1996 since their trees were damaged by typhoon Rosing that occurred in late 1995. Their citrus trees were also starting to bear fruit and they hoped to be able to sell fruit at some point. However, this year, they only harvested a few fruits for household consumption. Other fruits were used in the household and the forest trees have not yet reached harvest size.

The major use of perennials by this household was the regular harvest of small timber (usually *lauan*, *Dipterocarpus spp.*) from common areas at higher elevations about KM 12. They reported harvesting and selling approximately 1 medium-sized tree per month.

Other activities

The household did not report receiving income from other livelihood activities. The wife operated a small sari-sari store; however, the household did not perceive this to be a significant component of their income.

Estimated household budget

The household reported expenses for food, schooling and clothing. The household did not explicitly report needing to purchase rice; however, based on the rice yields reported above, the household needed to purchase rice this year for household consumption. School expenses were very low for a family with a child in high school. This was because they had been able to take advantage of the ICDAI scholarship mentioned earlier. As a consequence, their expenses for the high school student's schooling were minimal. Household expenses were off-set by income from the sale of timber and also the sale of agricultural crops (Table A2.28). In addition, the household made occasional use of short-term credit available from timber buyers.

Table A2.28. Estimated household budget for example household UM1

Income	Amount	Expense	Amount
Timber sales	P36,000	Food	P36,000
Agriculture	P10,000	School	P1,000
		Clothing	P1,000
Total income	P46,000	Total expenses	P38,000
Net income	P8,000		

Household UM2

Land

Household UM2 claimed use rights to 20 hectares of land, all of it steeply sloping. It was divided into 4, approximately equally sized parcels all located in the vicinity of KM 12. The land was vacant when they arrived in the area and they settled it and claimed use rights though this process. They did not, however, have any documents to back up their claim to any part of their land.

People

The household consisted of 3 people, a young married couple and their elementary school aged child. They ded not have any close relatives in the area.

Settlement and management history

The husband came to the area as a young man in 1983 from Lopez, Quezon, a town in Quezon province on the other side of the mountains. He was looking for land to farm and came to the area on the advice of a family friend who was a long-time resident. He initially worked for the family friend but was able to find his own piece of available vacant land. His wife grew up in Infanta. They were married about 8 years ago. Since their marriage, they had managed their land with the typical combination of annual and perennial crops. They started planting trees on their land 1991.

Present livelihood system

Their present livelihood system was a mix of upland annual crop cultivation, fruit tree cultivation, and the harvest and sale of rattan.

Annual crops

At the present time, example household UM2 cultivated four different annual crops: upland rice, ginger, taro and cassava. Although they did not specify the specific area planted to each crop, based on reported amounts of planting material I estimated that they had planted about one-half hectare of rice, one-third hectare of ginger and very small areas of taro (only 20 plants) and cassava (only 50 plants). Crop yields for rice and ginger (Table A2.29) were slightly below community averages. Since the amount of taro and cassava grown was so small, I did not estimate these yields on a per hectare basis. They did not use inputs on any of their annual crops. Rice, taro and cassava were all grown for household consumption. Ginger was grown for sale.

Table A2.29. Annual crops for example household UM2

Crop	Area (ha)	Yield	Yield/ha	Peso equivalent
Upland rice	0.5	150 kg	300 kg/ha	1,500
Ginger	0.33	170 kg	510 kg/ha	3,400
Taro	n/a	20 corms	n/a	n/a
Cassava	n/a	50 roots	n/a	n/a

Prices:Upland rice P10/kg, ginger P20/kg

Livestock

The household had very little livestock. They only reported having a small number of chickens to provide eggs and meat and one dog.

Perennials

They had planted a variety of perennial species on their land holdings, primarily fruit trees but also some forest species. Fruit trees planted include coconut (20), banana (50), avocado (10), coffee (20), *kidya* (*Citrus spp.*) (30), and mango (15). At this time, the coconut, coffee, citrus and mango trees had not yet reached bearing age. Avocado yields had been low so fruit had only been used for home consumption. Some banana had been sold with the rest being used by the family. They also reported planting melina (20) and *narra*, (20) trees on their land. They planned to sell these trees as timber when they reached marketable size. They also reported harvesting and selling *uway*, a type of rattan, on a regular basis. This rattan was collected both on their own lands and in vacant lands in the area and further into the mountains.

Other activities

The household did not report engaging in any other livelihood activities.

Estimated household budget

Example household UM2 reported expenses for food, household goods, schooling and clothes. These were off-set by income from rattan sales and from agricultural products, primarily ginger and fruits (Table A2.30). They did not use credit. Since they were a young family, both their income and expenses were low. If they decided to have more children and as their son advances in school, expenses would likely increase and the household would have to develop other sources of income. In the best case scenario, the perennial species on household land holdings would provide sufficient income on into the future. If not, the household would likely have to increase its reliance on forest products.

Table A2.30. Estimated household budget for example household UM2

Income	Amount	Expense	Amount
Rattan	P5,400	Rice	P7,000
Crops and fruits	P10,400	Food	P2,600
		Household / Clothes	P3,100
		School	P600
Total income	P15,800	Total expenses	P13,300
Net income	P2,500		

Household UM3

Land

Example household UM3 had access to 7.25 hectares of land. Seven of these hectares were in upland areas and 0.25 hectares were *bukid.* Both areas were located in *sitio* KM 9. Sufficient water was available from the river to irrigate the *bukid* parcel as necessary to produce two crops of rice per year. They inherited the land from the husband's father and reported having a title to at least part of their holdings. This was most likely the *bukid* parcel although they did not specify which one.

People

The example household was made up of a married couple, both about 60 years of age, and their 2 youngest children. They had a total of 9 children, ranging in age from 15 to 38. All of the children resided in the area with their families except for one daughter. One of their sons was still in high school. All of the other children have completed their education and several of the older children were married with children of their own.

Settlement and management history

Both the husband and wife grew up in the area although the husband was born in General Nakar municipality (north of Infanta). They inherited their land from the husband's father who had settled the area in 1940 with his young family (including the husband who was 9 years old at the time). They had lived there ever since. They used a management system based on cultivation of rice on their valley parcel and coconut on their uplands for a number of years. They reported first planting coconuts in 1965 when they took over the land as a newly married couple. They also planted bananas and other fruit trees and cultivated various upland (non-rice) annuals. Their primary system over time had been cultivating lowland rice for subsistence and selling copra to provide cash income. However, the household had harvested timber as a source of cash and continued to do so, particularly with the collapse of the copra market.

Present livelihood system

The present household livelihood system was based on both annuals and perennials. They were also one of the few households in the area that raised some small livestock. With the collapse of the copra market as a source of income, they also harvested and sold timber.

Annual crops

As mentioned above, the most important crop grown by the household was *palay bukid*. They grew two crops each year (one planted in May, one in December). They rotated between two improved varieties: BS-1 and IR 64. In addition to the rice, they grew ginger and pineapple on their upland parcel. Rice yields were low for *palay bukid* in general but were slightly above community averages. Pineapple yields were typical for the area. Since they did not provide ginger yields, I estimated the values based on the area planted and community average yields (Table A2.31). They used a small amount of complete (14-14-14) and urea fertilizer on their rice but did not use pesticides unless absolutely necessary (they did not use any during the past cropping season). Rice was used exclusively for home consumption while ginger and pineapple were sold.

Table A2.31. Annual crops for example household UM3

Crop	Area (ha)	Yield	Yield/ha	Peso equivalent
Paddy rice (1st crop)	0.25	500 kg	2000 kg/ha	4,000
Paddy rice (2nd crop)	0.25	500 kg	2000 kg/ha	4,000
Ginger	0.125	65 kg	520 kg/ha	1,300
Pineapple	0.5	2000 pieces	4000 pieces	10,000

Prices: Rice P8/kg, ginger P20/kg, pineapple P5/piece

Livestock

Unlike the majority of households in the area, this household had some livestock. They had 3 buffalo that they used as draft animals in paddy rice cultivation and for hauling. They also had 3 pigs that they were raising for sale. They had 20 chickens that provided both eggs and meat for household consumption, and they had the usual dogs and cats for security and rodent control respectively.

Perennials

In addition to the annual crops and livestock, example household UM3 had a significant number of perennial species on their holdings. The major perennial species was coconut. As mentioned earlier, they started planting coconut in 1965 and now have a mature grove of approximately 300 palms. They reported having sold copra in the past, but did not sell any during the last year due the extremely low market price. In addition to the coconuts, they also had 100 banana plants, 100 citrus trees and smaller numbers of other fruit species including mango, *santol*, sweetsop, cacao and rambutan. In addition to copra, they sold bananas in past years; however they did not sell any in 1996 due to the damage done by the November, 1995 typhoon. Their citrus trees also did not produce sufficient yield for profitable sale since they were still not fully mature. Other fruits were consumed by the household and their extended family.

In addition to the perennial fruits found on their own land, the household harvested and sold timber. Based on the amount of income they reported, I estimated that they harvested and sold one or two trees per month. The husband did the tree harvesting with the help of his sons who lived in the area; they then split the proceeds.

Other activities

Other than timber harvest, the household was not involved in other activities. Given the small size of the household, managing their own holdings and occasionally harvesting timber were ample activities to take up most of their working hours.

Estimated household budget

Example household UM3 reported three major expenses and two major sources of income (Table A2.32). In addition, they made use of occasional credit to buy food and household supplies. However, the money was borrowed from a friend with a small *sari-sari* store, the amount borrowed was small (no more than P1000), it was repaid quickly (within 1 or 2 months) and no interest was charged. Based on this estimated budget, the household had a significant surplus of income. This may be because their school expenses had recently gone down with the graduation of one of their children.

Table A2.32. Estimated household budget for example household UM3

Income	Amount	Expense	Amount
Timber harvest	P60,000	Food	P36,000
Crops and fruits	P24,000	School	P8,000
		Clothing	P4,000
Total income	P84,000	Total expenses	P48,000
Net income	P36,000		

Household UM4

Land

Household UM4 had access to 5 hectares of upland. The area was vacant when the household arrived and so they were able to claim use rights by improving the parcel. They had recently received a CSC for their holdings.

People

The household was made up of a recently widowed woman and five of her six children, ages 24 to 2. Her oldest son, age 26, was working abroad as a contract laborer. Two of her children were still in school, one in high school and one in elementary. The youngest child was still too young. The household had relatives in the area including siblings and cousins. The husband was from the Bicol region and arrived in the area in 1960 in the company of his family. The wife was born and grew up in the Infanta area. They moved up to their present residence in KM 12 in 1977.

Settlement and management history

They had lived in the area since 1977 and had managed their land using the typical long-fallow shifting cultivation system concentrating on annual crops. Unlike many other households, they had only recently started to diversify their enterprises through expanding areas planted to fruit trees. Since they had several children and two of their older children attended high school, it was likely that they harvested timber and also worked off-farm to meet school expenses. Since her husband's death last year, the widow had been managing her land with the help of her two older sons (ages 24 and 18) and her brother-in-law who lives nearby. She had concentrated on diversifying the present system and reducing daily labor requirements through a shift to fruit trees.

Present livelihood system

Their present livelihood system was a mix of annual crop cultivation and fruit trees. Money sent home by the oldest son who was working abroad was also important as was money from off-farm labor.

Annual crops

At the present time, the household cultivated small areas of several annual crops: *palay kaingin*, ginger, taro and cassava (Table A2.33). Rice and cassava yields were slightly below area averages while ginger yields were slightly higher. Since only a small number of taro plants were cultivated, I did not attempt to estimate yield on a per hectare basis. The household used no fertilizer or pesticides in crop production.

Ginger was grown for sale while rice, cassava and taro were grown for home consumption.

Table A2.33. Annual crops for example household UM4

Crop	Area (ha)	Yield	Yield/ha	Peso equivalent
Upland rice	0.5	100 kg	200 kg	P1000
Ginger	0.1	150 kg	1500 kg	P3,000
Taro	n/a	100 corms	n/a	n/a
Cassava	0.02	150 kg	7500 kg	P525

Prices: Upland rice P10/kg, ginger P20/kg, cassava P3.50/kg

Livestock

The household had only a small amount of livestock consisting of a few chickens for household use, one native pig that was being raised for sale, a watch dog and two cats for rodent control.

Perennials

As mentioned earlier, the household had planted increasing numbers of fruit trees in recent years. At the present time, their major mature fruit trees were bananas, that were used primarily for home consumption. They also had small numbers of jackfruit and citrus trees that were also used by the household. They had planted 100 coconuts and small numbers of mango and avocado trees. However, none of these trees had reached bearing age. The household did not make use of any forest products, either timber or rattan.

Other activities

Other income generating activities were important to the household. Of primary importance was the money sent home each month by the son who was working abroad. In addition, the mother and older sons worked off -farm as agricultural laborers during planting and harvest seasons. However, this type of work was not nearly as widely available as it was in either of the other two study communities.

Estimated household budget

Example household UM4 enumerated four major expenses and three major sources of income (Table A2.34). These were typical of households in this group. In addition, this particular household also had significant debts. In order for the son to obtain the necessary papers to work abroad, they borrowed a significant sum of money from the labor recruiter. This money must be paid back on a regular basis and interest charges were very high by US standards (10% / month).

Table A2.34. Estimated household budget for example household UM4

Income	Amount	Expense	Amount
Money from abroad	P24,000	Food	P24,000
Off-farm labor	P7,000	School	P8,000
Ginger sales	P3,000	Clothing	P1,000
		Household goods	P1,000
Total income	P34,000	Total expenses	P34,000
Net income	P0		

Assumptions: 100 days total off-farm work annually, P70/day wages

Appendix 3
Text of survey questionnaire administered to community residents
(English translation)

FARM SURVEY

Name of study community (Imbarasan / Mapaya, Upper Magsaysay, or Halang)

Supervised by Michael Robotham

Department of Agronomy and Soil Science

University of Hawaii at Manoa

Honolulu, Hawaii

Survey Number: _____

Interviewer Name: ____________________

Farm Location: ____________________

Date of Interview: __________

Questions about Land

1. How big are your land holdings? (ha)

2. Do you have lowland holdings? Yes No

   If yes, then:
   - 2.1 How big is it? (ha)
   - 2.2 What is the soil type or soil color?
   - 2.3 Do you have water for your holdings during the dry season? Yes No

   If yes, then:
   - 2.4 Where is the water from?
     - a. Stream or river
     - b. Well
     - c. Other
   - 2.5 How large is the area that you can irrigate?

3. Do you have upland holdings? Yes No

If yes, then:
3.1 How many parcels do you have? ______

Please answer the following questions for each parcel
(Respondents were asked to provide information for up to four parcels)

How large is the parcel? ________ ha

What is the slope? (see slope guide)
a. flat
b. gently sloping
c. moderately sloping
d. steeply sloping

What is the type or color of the soil?

How do you use the parcel?
The surveys in each site included four possible responses based on the most common land uses in the area as well as a choice of "other".
Possible options included: *kaingin*, *bantod*, *bukid*, banana orchard, mango orchard, coconut orchard, grassland, jungle, and "other".

Questions about the respondent:

4. When did you first arrive in the community? __________

4.1 Where are you from? ________________________

4.2 What are your native language(s)? ____________________

5. When did your spouse first arrive in the community? ______

5.1 Where are they from? ______________________________

5.2 What are your native language(s)? ______________________

6. Why did you move to this community? ____________________

7. How did you get your land holdings?
    1. No one was using the land so I settled there
    2. Inheritance
    3. Purchase
        3.1 How much?
        3.2 From whom?

8. Do you have papers to prove you have use rights for this land? Yes No

    If yes, then:
    8.1 What are they?
        1. Certificate of Stewardship Contract (CSC) from the DENR
        2. Land title
        3. Tax declaration
        4. Certificate of land transfer (CLOA) from the DAR (Halang only)
        5. Other

Questions about the livelihood system:

Crops:

9. Respondents were asked to provide the following information for each annual crop grown in the past year (space was provided in the survey form for up to 10 crops):
    1. Name of the crop
    2. Area planted to the crop
    3. Month when crop was planted
    4. Approximate amount of planting material used
    5. Month when crop was harvested
    6. Approximate amount of the harvest
    7. Primary use for the crop (e.g. home consumption, sale, etc.)

10. What are your two most important crops?
    Why?

11. For the most important crop listed in number 10:

11.1 How have your yields changed from years past?.

a. Generally decreased
b. Generally increased
c. More or less the stayed the same
d. Up and down – there have been good years and bad years

11.2 How often does your yield "crash" -- you get no or very low harvest?

a. Every other year
b. One year in five
c. One year in ten
d. One year in twenty
e. Whatever happens, you always get something

12. For the second most important crop listed in number 10:

12.1 How have your yields changed from years past?.

a. Generally decreased
b. Generally increased
c. More or less the stayed the same
d. Up and down – there have been good years and bad years

12.2 How often does your yield "crash" -- you get no or very low harvest?

a. Every other year
b. One year in five
c. One year in ten
d. One year in twenty
e. Whatever happens, you always get something

13. Do you use fertilizers? Yes No

If yes, then:

To which crops do you apply fertilizer?
What type of fertilizer do you apply?
How much fertilizer do you use?

14. Do you use pesticides (including herbicide, insecticide, fungicide, molluscicide, etc.) Yes No

If yes then:

To which crops do you apply pesticides?
What types of pesticides do you apply?
When do you apply pesticides?

15. Are there crops that you have grown in the past but are not growing now?
Yes No

16. If yes, please provide the following information about the crops:
    1. Name of the crop
    2. When you last planted the crop
    3. Would you like to plant it again?
    4. Why or why not?

Animals:

17. Please provide the following information for all animals raised by your household?
    1. Type of animal
    2. Number of animals
    3. Primary use of the animal (e.g. farm work, food, sale etc.).

Trees (perennials)

18. Please provide the following information for all tree (perennial) species currently managed on household land holdings?
    1. Name of the tree (perennial)
    2. Number of individuals
    3. Primary use of the species (e.g. food, timber, fuel wood, charcoal etc.)

Other products:

19. Did you harvest any other useful products in the past year including imperata grass, rattan, trees, fish, etc.? Yes No

    If yes, then:
    For each product, please provide the following information:
    1. Name of the product?
    2. Origin (forest, own holdings, stream etc.)
    3. Number harvested
    4. Price (paid to harvest, or received if the product is sold)
    5. Use of the product (household use, sale, etc.)

Information about your family:

20.1 How old are you?
20.2 How old is your spouse?

21. Do you have children? Yes No

If you have children, please provide the following information for each child:
1. Age
2. Gender
3. Where they live now
4. Current grade in school or the highest grade they finished.

*****
The following section was used in the Halang survey instead of questions 20 and 21 above.

20.1 How old are you?
20.2 How old is your spouse?

Question to the interviewer: Please indicate the gender of the survey respondent?

20.3 What is the highest grade you finished in school?
20.4 What is the highest grade you spouse finished?

How many children do you have? Total Male Female

How old is your oldest child?

How old is your youngest child?

Where do your children live? (Please indicate how many of each gender live in each place)

In your house	____	Male	____	Female
In Halang (but in their own house)	____	Male	____	Female
In a nearby town	____	Male	____	Female
In Manila	____	Male	____	Female
In another part of the Philippines	____	Male	____	Female
Abroad	____	Male	____	Female

How many children are in school this year?

In elementary (primary) school ________

In high school ________

In college ________

Counting all of your children, how many of each gender have finished the following levels of schooling?

Elementary (grade 6)	____	Male	____	Female
High school	____	Male	____	Female
College (2 years)	____	Male	____	Female
College (4 years)	____	Male	____	Female

******

22. Do you have relatives in the community? Yes No

If yes, who are they (circle all that apply)

1. Parents or in-laws
2. Siblings
3. Uncles/aunts
4. Cousins

Expenses and income sources:

Expenses

23. What are your five most important expenses?

For each expense please provide the following information:

1. Type of expense
2. How much (approximately)?
3. How often do you have the expense?

Income

24. What are your five most important income sources?
    Please provide the following information for each income source?
    1. Income source
    2. Amount (approximate)
    3. How often do you receive this income

Credit

25. Do you need to borrow money?
    25.1 How much (approximate)?
    25.2 How frequently?
    25.3 From whom?
    25.4 For what purpose?
    25.5 How much is the interest?

Other:

26. In your opinion, what are the problems associated with life in your community?

27. In your opinion, what are the good things about life in your community?

Glossary

bantod An upland area that is cultivated using a plow. Unlike bukid, this land cannot be flooded for rice cultivation. This word is Hiligaynon, not Tagalog, and was used only in Imbarasan / Himamara.

barangay Smallest official unit of Philippine government. A group of barangay make up a municipality. Barangay divisions are determined primarily by population, not land area.

bukid Land cultivated using a plow. In Halang and Upper Magsaysay, this word refers to both land that could be flooded and land that could not be flooded. In Imbarasan / Himamara, the word refers to land that can be flooded (see bantod).

gubat Jungle, used in all three communities to refer to land covered by secondary or primary forest.

jeepney Passenger vehicle that is the primary form of motorized transportation in the rural Philippines. It is about the size of a large sport utility vehicle and can carry as many as 40 people and a variety of cargo.

kaingin Verb: a method of land preparation that is based on clearing land by cutting and burning the existing vegetation and then planting (without plowing) into the ash newly cleared soil.
Noun: an area of land that has been, is being, or will be used for this type of cultivation.

lupa Soil

sari-sari store A small retail establishment common in the rural Philippines. Small amounts of basic household necessities along with soda, beer and candy are commonly sold at these stores.

sitio The smallest locally-recognized community division in the Philippines. Rural barangay that cover a large area of land are divided into a number of smaller sitios.

Note: Tagalog words for plant and animal species used in the dissertation are not included in this glossary, but thay can be found in tables A1.1, A1.2 and A1.3 in Appendix 1.

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